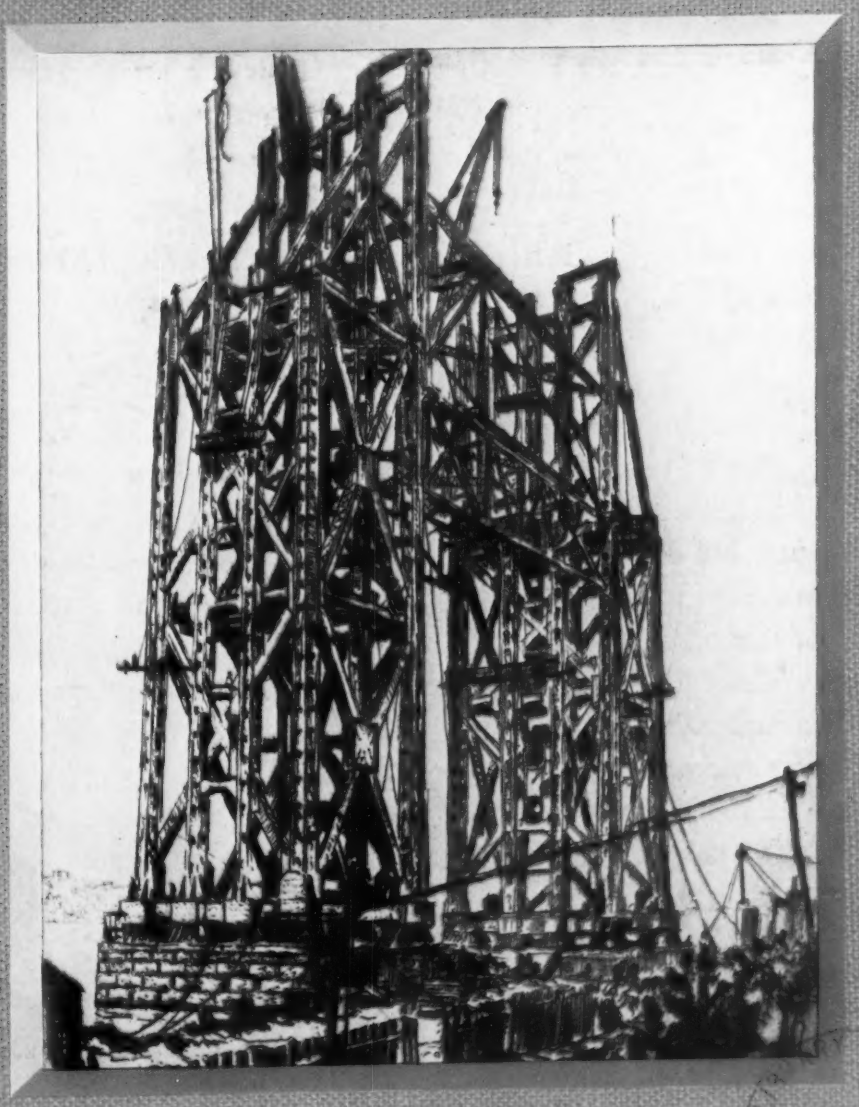
THE TECH ENGINEERING NEWS

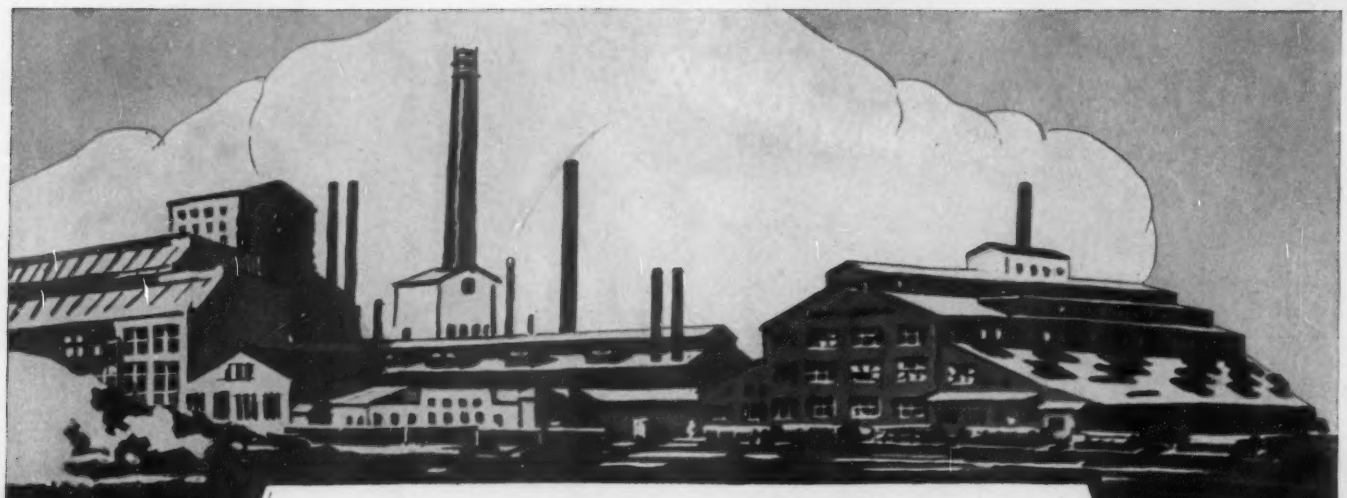
MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED



LIBRARY OF CONGRESS
JAN
PERIODICAL DIVISION

MASSACHUSETTS
INSTITUTE OF
TECHNOLOGY

VOLUME IX, NO. 7
DECEMBER, 1928



MAKING STEAM FOR INDUSTRY

Steam Generation is a combined process of heat liberation and heat absorption. The fuel burning equipment, the furnace and the steam boiler must be co-ordinated in one unified design—to assure efficient and dependable performance.

There is no sharp dividing line between the responsibilities of the stoker or burner manufacturer, the furnace builder and the boiler maker. The performance of individual elements is secondary to the performance of the combination—as a unit.

The ultimate goal sought is to produce steam at the minimum cost, giving proper consideration to all the factors which enter into the problem of steam generation.

This company offers—one contract, one responsibility—for complete fuel burning and steam generating installations.

Combustion Engineering Corporation

International Combustion Building
200 Madison Avenue - - - New York

A SUBSIDIARY OF INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

NEW YORK
LIFE BUILDING
CASS GILBERT
Architect

ONWARD AND UPWARD

TODAY Civilization marches onward and upward. The development of a city requires tall buildings which increase land values by giving added income from costly real estate.

The elevator by making the skyscraper possible has in this way added untold wealth to the cities of the world.

Developed step by step from the crudest early apparatus, the modern elevator is a marvel of mechanical genius—speedy, safe, dependable.

Since Elisha Graves Otis produced the first safe elevator in 1852, Otis has been the "World's Word for Elevator Safety".

Reproduction from an old print showing one of the steps toward present day Vertical Transportation.

OTIS ELEVATOR COMPANY

OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD

Pneumatic Tools
Without the riveting hammer, or "gun," as it is sometimes called, we should have no towering skyscrapers—none of the massive structures that characterize our modern industrial life.
Few, however, understand the important work that falls to the lot of other pneumatic tools. Chippers, drills, grinders, hoists—they replace hand labor in every trade and speed the output of all our present-day commodities.
The Ingersoll-Rand line includes over 1,000 sizes and types of air compressors and as many labor-saving pneumatic tools.
INGERSOLL-RAND COMPANY
11 Broadway • New York City
Offices in principal cities the world over
Ingersoll-Rand
R-1704

A Hercules Glazier Entering Top of Glaze Mill with Car of Green Grain.

The Powder Maker

Considering how important his work is to the public, it is fitting that more should be known about the powder maker and his job.

The characteristics which fit him for his work are as largely mental as physical, and the work itself develops his acuteness of mind – his powers of observation, judgment, and decision.

The powder worker trained in the school of the Hercules plants learns to take in all his surroundings at a glance. If he enters one of the small buildings on a dynamite or black powder line nothing escapes him. He sees instantly many things which by the ordinary observer would be unnoticed.

A large part of the explosives used in the United States is made by the men in Hercules plants.

Behind all our manufacturing industries and our railroads, behind all the useful and beautiful objects fashioned out of metals stands the powder worker. Without the explosives he supplies—hundreds of millions of pounds annually—the miner's efforts to move the vast inert bodies of ore and coal would be as futile as the scratching of hands.

HERCULES POWDER COMPANY
(INCORPORATED)

HERCULES POWDER COMPANY, Inc., 941 King Street, Wilmington, Delaware

Sign and mail this coupon for a free sample copy of The Explosives Engineer—the only magazine devoted to promoting safe and efficient methods of blasting about which every engineer should know something.

Name _____ *College* _____

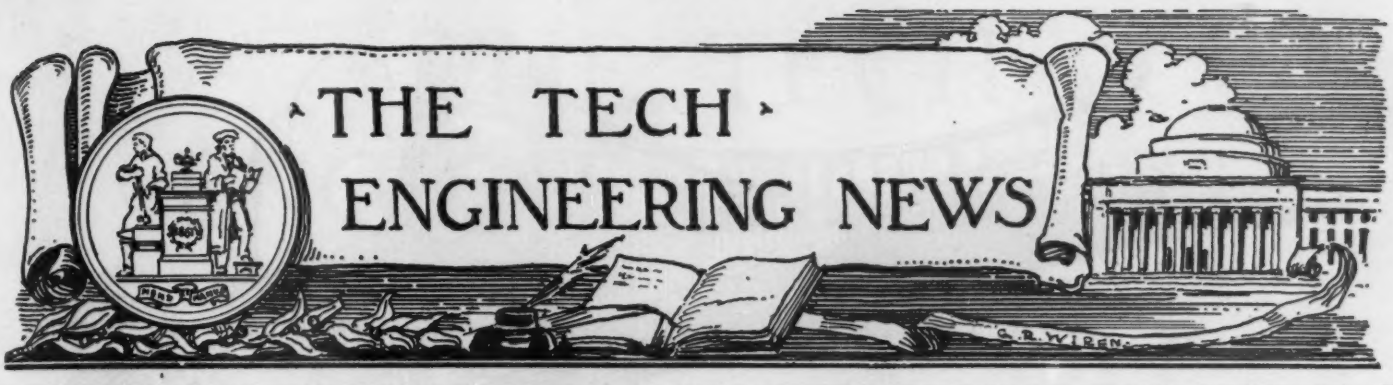
Street _____ *City* _____ *State* _____ 2397

Paul Bunyan Is Here!
In those delightful fables of the North Woods, Paul Bunyan does wondrous works, far beyond the realm of human possibility, always on a gigantic scale.
But what was the miracle of yesterday is the reality of today. Norton Pulpstones — modern giants — with speed and regularity shred the millions of logs which flow down to the paper mills.
Mere man could not compete with Bunyan in the North Woods. Even so the old quarried sandstones yield to the prowess of pulpstones, manufactured by Norton. The North Woods bow in homage to the new abrasive giant.
Norton Company, Worcester, Mass.

NORTON

Grinding Wheels
Grinding Machines

Refractories-Floor
and Stair Tiles



Volume IX | CAMBRIDGE, MASS., DECEMBER, 1928 | Number 7

Copyright 1928 by The Tech Engineering News

Entered as second class matter, June 1, 1920, at the Post Office at Boston, Mass., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 3, 1920.
Published monthly throughout the school year by the undergraduates of the Massachusetts Institute of Technology for the purpose of disseminating news of scientific and industrial interest and of promoting closer co-operation between Alumni and undergraduates.

THE MANAGING BOARD

ADAM K. STRICKER, JR. '29 — *Editor*
WILLIAM BAUMRUCKER, JR. '29 — *General Manager*
THOMAS H. SPELLER, JR. '29 — *Business Manager*
CHARLES F. EDLUND '30 — *Managing Editor*
B. KING COUPER '29 — *Publicity Manager*
CHARLES C. LADD '30 — *Circulation Manager*
A. ALLAN HORNE '30 — *Advertising Manager*
HOWARD S. GARDNER, JR. '30 — *Associate Editor*

EDITORIAL DEPARTMENT

HOWARD A. ROBINSON '30 . . . . . *Assistant Editor*
CHRISTIAN E. GROSSER '31 . . . . . *News Editor*

EDITORIAL STAFF

E. H. ANDERSON '32
C. CHAYABONGSE '32
R. C. M. CALVERT '32
J. H. DODGE, JR. '31
N. D. FITZGERALD '31
T. HARPER '32
I. W. HILLIARD '32
I. R. MITCHELL '31
R. E. JOHNSON '32
H. G. PROTZE '32
C. W. RANKIN '31
W. F. SPREEN '32
A. G. STOCKWELL '32

BUSINESS DEPARTMENT

ANTHONY R. SAVINA '30 . . *Assistant Business Manager*
JOHN P. DAHLBERG '31 . . . *Assistant Publicity Manager*
RICHARD T. KROPF '31 . . . *Assistant Circulation Manager*
GEORGE M. ORNE '31 . . . *Assistant Circulation Manager*
HERBERT E. RAYMOND, JR. '31 *Assistant Circulation Manager*
CHARLES R. WOOD '31 . . . *Assistant Advertising Manager*
NELSON B. HASKELL '31 . . *Assistant Advertising Manager*

BUSINESS STAFF

A. D. BERTOLETT '31
F. S. CHAPLIN '32
H. E. CLEMENTS '32
D. W. BROOKFIELD '32
S. EDELSTEIN '32
K. J. HEINICKE '32
G. D. JOHNSON '32
J. E. LINZ '32
E. A. NEWCOMB '32
A. M. MAGUIRE '32
P. P. SHELBY '32
R. M. STEWART '32
P. C. SMYTH '31

THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman, Mr. Willard V. Merrihue, 1 River Road, Schenectady, N.Y.

The Transit
Iowa Engineer
Colorado Engineer
Nebraska Blue Print
Pennsylvania Triangle
Sibley Journal of Engineering
Purdue Engineer
Rose Technic
Michigan Technic
Ohio State Engineer
The Tech Engineering News
Wisconsin Engineer
Penn State Engineer
Technograph
Cornell Civil Engineer
Minnesota Techno-Log
Kansas State Engineer
Kansas Engineer
Princeton E. A. News Letter
Armour Engineer
Oregon State Technical Record

SUBSCRIPTION PER YEAR, $1.50
Address all communications to The Tech Engineering News, Walker Memorial, Cambridge 39, Massachusetts. Telephone, University 6864
Advertising rates upon application

TABLE OF CONTENTS

	Page
THE INDUSTRIAL MUSEUM AS AN AID TO TECHNOLOGY. By F. C. Brown	283
SCIENCE AND FIRE FIGHTING. By E. R. Schwarz '23	285
TECHNICAL TRAINING — PLUS. By Thomas J. Litle, Jr.	287
INDUSTRIAL POSSIBILITIES OF X-RAY EXAMINATION. By John T. Norton '18	288
THE INDUSTRIAL APPLICATION OF MICROBIOLOGY. By Samuel C. Prescott '94	290
THE COÖPERATIVE COURSE IN RAILROAD OPERATION. By John B. Babcock '10	292
EDITORIALS	293
THE ENGINEERING FIELD	294
DEPARTMENTAL NOTES	296
BOOK REVIEWS	298

The TEAM, The COLLEGE, The CLUB
All need it—
AND SO DOES ANY PROJECT

Any man who has played on a team, taken part in glee club, newspaper or college activity knows that success is often attained only by co-ordinating the experience of many persons in one organization.

Stone & Webster is prepared to help plan and organize a new development in any field of enterprise. Within its organization are engineers to make investigations, reports or appraisals preliminary to financing. More than that, Stone & Webster can provide financial plans and assist in financing. It can carry out work of any type or magnitude, providing complete designs and construction personnel.

You will find Stone & Webster on the job in almost every state in the Union and in many foreign countries. When you leave college, you'll find these men ready to help you, ready to give you the benefit of 39 years' experience in financing, operating, and building. You'll find the Stone & Webster organization is worth knowing and worth doing business with.

STONE & WEBSTER
INCORPORATED

OPERATE FINANCE BUILD

© CIB 12531

DEC 26 1928

THE TECH
ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME IX DECEMBER, 1928 NUMBER 7

The Industrial Museum as an Aid to Technology

The benefits to be derived from a better unaerstanaing by the people as a whole of the jactors in our industrial development

By F. C. BROWN
Director, Museums of the Peaceful Arts
New York City

WHILE this article concerns itself with the general idea presented in the title above, the idea will be more specifically presented in connection with the work of the New York Industrial Museum as established under the Association for the Establishment and Maintenance for the People in the City of New York of Museums of the Peaceful Arts. This institution has been functioning in a small way now for more than a year on two floors at 24 West 40th Street. We therefore have some first-hand experience which enables us to speak of the manner in which such a museum may aid in the development of technology. For example, during the last two months the museum has had nearly 4,000 visitors, who have spent from one to five hours studying the exhibits. Among these have been the students of technical and other schools, engineers, scientists and executives of our leading industrial establishments. The interest of all these visitors has been very great, judged by their kind words, their suggestions and their offers to coöperate with exhibits and otherwise.

A museum in its present stage was made possible through the will of the late Henry R. Towne. In it, he stated in part:

"In order that said association, its officers, managers and directors may know and be impressed with the importance and value placed by me upon the objects and purposes for which said association has been incorporated, and the great public benefit that may be derived therefrom, I wish them, in their endeavors to promote the purposes and best interests of said association, to have in mind constantly the following facts, *viz.:*

"That the United States is the greatest industrial nation of the world; that its inventors and industrial leaders have won the foremost place in almost every field of applied science; that its organized industries excel those of all other countries in magnitude and efficiency; that their products are in demand in all the markets of the world and that their future welfare is increasingly dependent upon the retention and expansion of their export trade; that our national achievements in this great field are unrepresented by any permanent collection of examples illustrative of their history and growth, or of their present development; that while we have many magnificent museums of ancient and modern art, and, in this city, a splendid Museum of Natural History, we do not possess any permanent exposition of American achievements in the peaceful arts; and that this great group, for which this plea is made, includes the arts of Agriculture and Animal Industry; of Forestry and Woodworking; of Mining and Metallurgy; of Transportation and Communication; of Engineering and Architecture; of Industrial Chemistry; of Electrical Mechanism; of Aeronautics; of the Metal, Textile and Building Trades, and of the innumerable subdivisions of all of these, including their Products, Processes and Implements."

Museums are an exceedingly important factor in our educational system. The Industrial Museums of Europe, especially that at Munich, are examples as to the value of this particular type of museum which is so rapidly finding favor in this country. In a few years one will be found in each of the large centers of population.

The public finds such collections interesting and instructive. They are the inspiration of youth fitted by nature for work in the fields of science, engineering or industry.

Samuel W Stratton

I may add that in view of the interest already aroused, the authorities have every reason to expect that we will soon develop into an appropriate independent housing commensurate with the importance of our city and with the important part that industry has played in elevating the city to its present eminence.

The museum already has several hundred exhibits which, in spite of the disconnected manner in which they are shown, do interest the technical man and the layman alike. Among the exhibits of a historical nature are:

The Eli Whitney Milling Machine, as well as other types up to the year 1879.

The Blaew Printing Press, the oldest in America.

A working model of the first Victrola.

An early Edison tin foil phonograph.

A model of America's first power station for incandescent lighting.

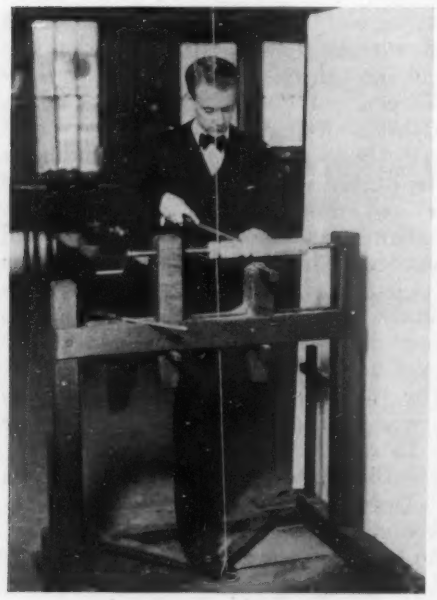
The exhibits that have maximum attraction as well as maximum educational value are the operating exhibits. Some examples among these may be mentioned. There is a model wind tunnel from the Bureau of Standards. The visitor turns on the air current by pressing a button. With his other hand on a dial, he regulates the relative

speed between the model plane and the air. He observes how the lift of the aeroplane varies with the varying air current, and also he observes, by means of a very old anemometer outside the wind tunnel, how the air is returned to the tunnel.

In aviation, there are also the turn indicator and the earth inductor compass, which the visitor can operate and study without the aid of a guide. These are duplicates of the ones used by Colonel Lindbergh in his transatlantic flight. They were made up especially for the museum by the Pioneer Instrument Company.

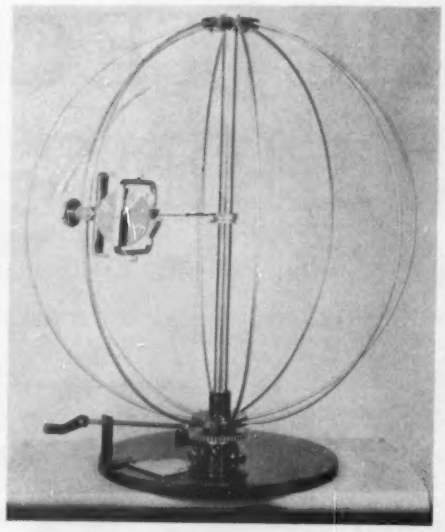
An exhibit that pleases everyone is a steel rail which the visitor can bend by the application of pressure by his finger at various places. Also he can press the top of the rail with his hand and observe the bowing of the rail as a result of the expansion of the upper surface. The student invariably learns two things from this exhibit in a concise and dramatic manner, namely, that there is no lower limit below which the applied force does not produce deformation; and second, he gets a rather concrete idea of the smallness of a light wave as used in interferometer measurement. Along with this exhibit, the student can measure at the museum, in a minute's time, the length of a light wave in terms of the dial gauge. This latter exhibit is a joint one by the Bureau of Standards and Keuffel & Esser.

In the field of radio, there are two



OLD FRENCH POLE LATHE
This lathe can be operated by the visitor

operating wave meters. There is a short wave-length sending station built by the General Electric Company, whereby the visitor can produce standing short waves and measure the length of these waves made visible.



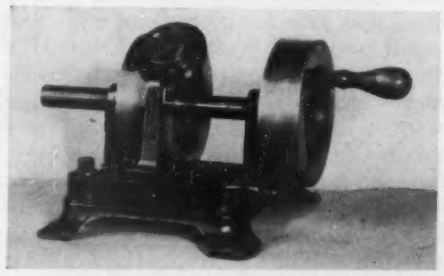
VISITOR OPERATED GYROSCOPE
Rubber bands act like gravity and the compass points north as earth revolves

The Bell Laboratories have placed a combination oscillograph and telephone transmitter, which enables the visitor to study the wave form of his voice. All these are only illustrations which might be multiplied many times.

Perhaps the greatest contribution of the museum will be in raising the level of technical understanding of the average man, or rather, layman. And, in a way, everybody nowadays is a layman except in one particular field, or a few fields at most. The mechanisms of our age are so great that no man understands all of them, and to most men they are even more a mystery than are the stars in the heavens. It will mean much to the progress in business relations if the banker, the engineer, the educator and the workman can all talk somewhat the same language, and by that I mean, have an inkling of the same understanding of what the language means. The banker cannot be expected to be expert in the electron theory, anthropy, thermodynamics or cosmic radiation. But it would be stimulating and useful to him and would make him very proud if he could have a little understanding as to how these abstruse things are at the very foundation of many of the new industrial developments for which the banker stands to make or lose. We might equally well say that the manufacturer of textiles would gain much from a popular exhibit of the methods and processes in industrial chemistry which are working to aid and to compete with the old line of production.

The whole secret of the industrial museum is, after all, one of economy, and rests upon the foundation that operating models and parts of models, sectioned and otherwise, can give understanding for which there is not otherwise means or time.

And there is another use for the museum that has already proved itself. Manufacturers, experts, writers and inventors come to the museum for help on particular problems, and as the line of exhibits increases, that number will undoubtedly multiply. During the last month, for example, we have had the following illustrations: One man sought information as to sound-proofing material to be used in radio studios. The engineer of a company having manufacturing establishments in many cities sought assistance in the use of molding sand for cast-iron cores. The engineer of a well-known manufacturer came seeking information as to the methods of obtaining controlled motion with a tolerance of less than one ten-thousandth of an inch. An oil producer wrote a letter of many pages seeking information on the relationship between the electrical and magnetic means of studying the variations of the earth's outer shell. A consulting engineer sought information as to the working of the old Walking Engine of 1813. Some one wished advice on electroplating a spot weld. And another wanted all the information he could gather relative to the applicability of ultra-violet light to the stage. In addition, there have been many questions having to do with mechanical motion, such as the means of producing reverse motions as in washing machines; the motions in lock and



EARLY PHONOGRAPH
One of the first made by Edison

advance movements; the method for starting sewing machines when a person has both hands occupied; a specially controlled intermittent repeating motion; reverse differential speed model; a motion controlled with intermediate endless bolt; explanation of spider gears; a means to translate diaphragm vibration into continuous motion; assistance for special device in sand cleaning machine in connection with mining, etc.

Quite apart from the above considerations, the museum, with its collection of both operating and non-operating models, will be a storehouse of information for all those who wish to arrive at truth through the study of the past. Perhaps many of the models and parts which will not be of interest

(*Continued on page 314*)

Science and Fire Fighting

Pointing out the advances that have been made in fire-fighting methods and equipment as a result of scientific research

By E. R. SCHWARZ '23
Instructor, Department of Mechanical Engineering, Massachusetts Institute of Technology

WATER has long been the fire fighter's most powerful weapon. It is effective both for the extinguishment of fire and for the prevention of spread of flame. In the former case it cools materials below a point where they burn readily, and in the latter it wets down surrounding combustibles, thus rendering them difficult of ignition. For many years the progress of fire fighting has been measured by the improvements in the methods of handling water, and in the increase of quantities and pressures available. Where quantity was measured by the bucketful, and capacity by the level of water in the nearest well, and where pressures were dependent upon the muscular development and stamina of the volunteer crew manning the hand tub, or was lacking entirely, the fire loss was largely due to actual destruction by burning.

As centers of population developed and cities increased in number and in congestion, as well as in concentration of high values, full-time, paid municipal fire departments were organized. Apparatus was horse-drawn, and with the advent of suitable hose and the steam pump, the fire brigade was no less picturesque, but much more efficient. With the municipal water supply to draw from through convenient systems of piping and hydrants, the problem became not one of adequate amounts of water at suitable pressures, but rather a question of using the smallest quantity of water possible to prevent excessive water damage to portions of a building or its contents in which there was no fire. The consequent advent of chemicals for fire fighting was a recognition of the fact that fire, after all, is only a rapid oxidation — in the last analysis, a chemical reaction — and could be conquered on that basis. The chemicals not only had a cooling effect, but non-combustible gases were formed sufficient to shut off the supply of oxygen from the burning substance and thus strike at the source of the menace.

Courtesy *American La France and Foamite Corporation*

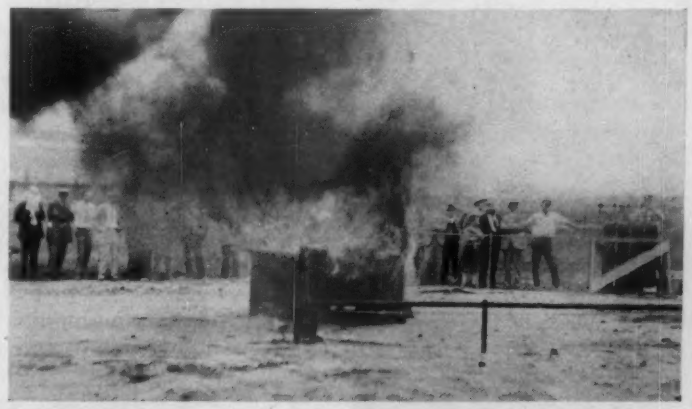
HAND TUB (1798)
Note the leather pail and longitudinal seam in the hose

Modern science can now place at the command of the fireman and of the fire protection and prevention engineer the results of research leading to the utilization of more efficient means for "blanketing" a blaze and at the same time, for cooling even the most inflammable of liquids below its flash point.

The advent of "foam" as a means of fire extinguishment was a long forward step. A heavy and long-lived foam made up of bubbles containing carbon dioxide gas can now be rapidly spread over the surface of a burning liquid, the foam serving not only as a blanket in itself, but preventing in large measure the escape of the inert gas.

Oil and gasoline fires of very considerable magnitude can now be controlled and in most cases quickly extinguished by the proper use of foam. This substance is generated by the union of two solutions at the blaze. Improvements have led to what is known as a foam "generator," which utilizes a jet of water under pressure to mix with two powders poured simultaneously into a double tank or hopper. A standard fire hose carries the foam under pressure and delivers it several hundred feet away — much as a stream of water would be handled. The generator can conveniently be made small enough to carry on the running board of a piece of fire apparatus, and is as simple to use as an ordinary hose and hydrant connection. Since material can be continuously added to the hopper of the generator, a comparatively unlimited amount of foam is available in contrast to the fixed quantity at hand in the ordinary tank or extinguisher.

While foam is a valuable adjunct to fire fighting equipment, it does not always minimize the loss, and since it is a good conductor of electricity, it is unsuited to work on electrical apparatus. Materials such as lacquer, which, in our day, are more and more coming into use, not only present a serious fire



Courtesy *Factory Mutual Record*

FIRE AT ITS HEIGHT

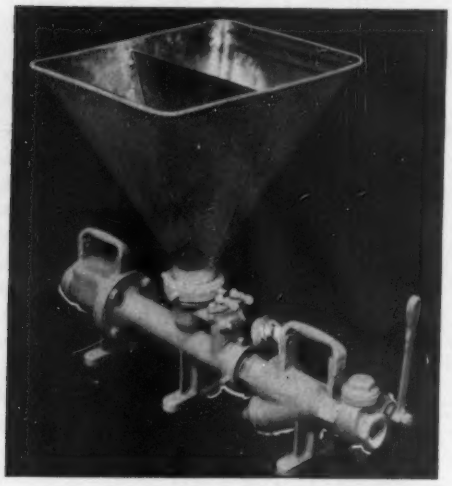
The operator at the right is about to open valve on the CO_2 tank. Perforated pipes in the bottom of the tank allow the gas to pass up through the liquid, cooling it and forming a blanket at the surface which extinguishes the fire by cutting off the supply of oxygen.

Courtesy *Factory Mutual Record*

A FEW SECONDS LATER

The fumes rising from the tank are CO_2 escaping in a white cloud, and blanketing fire

hazard, but are expensive to replace if spoiled by mixing with a substance like foam. Then, too, certain chemicals — alcohol, for example — dissolve the foam as fast as it forms. Therefore, CO_2 in a liquid form is coming into use with much success when properly handled. It requires some skill and experience to use successfully, and cannot be used with entire satisfaction on all types of fires. It has, nevertheless, many advantages.



Courtesy *Associated Factory Mutual Fire Insurance Co.*

FOAM GENERATOR

The two powders are poured simultaneously into double hopper. Water enters pipe at the left and foam emerges at the right.

It can be stored in the liquid form indefinitely without deterioration, which is not true of other types of chemical extinguishers. It forms an inert gas by expansion on its release from the container, and due to its thermal properties, attains a temperature of $-100°$ F. As it issues from the conical nozzle of the hand extinguisher, it is in the form of a dense white fog or snow, and can thus be readily directed. Its existence in a gaseous form eliminates loss by wetting down, and it has no corrosive or staining effect as do certain other chemicals. When forced through a tankful of burning liquid by means of a submerged, perforated pipe, it not only cools the liquid below its flash point quickly, but forms a blanket over the surface of the liquid, thus shutting off the supply of oxygen and effectively smothering flame. The writer has witnessed a test in which a large tank of cylinder oil mixed with gasoline was ignited and allowed to burn fiercely for fifteen minutes. The CO_2 was then admitted to the submerged piping and in less than a minute the fire was out, and the contents of the tank could be stirred with the bare hand without discomfort.

Since the CO_2 is an inert gas it passes off into the air and the liquid is uncontaminated except by the products of its own combustion. It is a non-conductor of electricity, and due to its properties will not corrode or damage electrical wiring or apparatus, however delicate. Thus the use in telephone exchanges, power plant switchboards, etc.* In spite of its low temperature it is not dangerous to handle, due to the perfection of equipment attained through constant experimentation. It seems likely that the old saying "*Fight fire with fire*" will have to be amended to "*Starve the fire and freeze it to death.*"

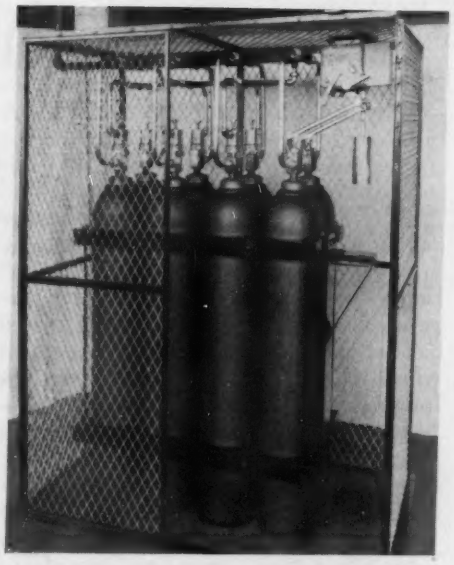
As an example of scientific progress, consider a typical installation of CO_2 for the protection of a large motor-generator or turbo-generator set. Batteries of tanks of liquid carbon dioxide at pressures ranging from 750 to 1,000 pounds per square inch are arranged with electric releases under automatic time control, so that in event of a fire they are opened in succession at just the right intervals to maintain better than a minimum effective concentration of CO_2 in the air ducts of the generator and in and around the generator itself. The release may be manually actuated; may be tripped by the action of any one of a number of thermostats at any sign of undue heating; or by the interference of fumes with the beam of light impinging upon a selenium cell. This latter forms a smoke detector. Where there is smoke there is fire, is the hypothesis here, and since seconds at the beginning of a fire are more valuable than hours after it is once well under way, the device is valuable as something of a preventive measure.

For some time, fire departments abroad have been using equipment designed to force fresh air into a smoke-filled building, thus making the entrance of firemen into the structure easier, and increasing the length of time they may work inside. In this country, several chiefs of department have experimented with the converse of this. In one device, which is classified as fairly successful, a hose stream drives a water-motor directly connected to a large suction fan. Flexible metal tubing of adequate diameter can be run from the intake of the fan to a smoke-filled basement or room, and draw out the smoke. The water leaving the motor is used to cool the fan blades in case flame is sucked through the tube, or in case the gases are too hot. The device is not yet perfect, and much care and judgment must be exercised as to the time and place of its use, but the possibilities are good.

The use of artificial products such as celluloid and kindred materials has created a serious condition in dwelling house fires as well as in commercial plants. The fumes resulting from the combustion of these substances are extremely poisonous, and many firemen have been overcome, put out of action, or killed outright. Thus the gas mask has developed another peace-time use, but needs perfecting for this particular field. The possibility of obtaining a supply of pure air for breathing purposes from the trapped air in a hose stream can be developed, and is typical of a multitude of phases of fire fighting which can and should be thoroughly investigated.

(*Continued on page 300*)

*See National Fire Protection Association *Quarterly*, October, 1928. "Carbon Dioxide Fire Protection," Moulton.



Courtesy *American La France and Foamite Corp.*

TANKS OF CARBON DIOXIDE

Two tanks at the right are released electrically, and the valves operated by the falling weight.

Courtesy *Factory Mutual Record*

A STREAM OF FOAM

A foam generator leads to hose line, and delivers a stream of foam handled like an ordinary fire stream. Used to blanket burning oils.

Technical Training—Plus

Some interesting experiences illustrating the qualities demanded of an engineer in practice

By THOMAS J. LITLE, Jr.
Chief Engineer, The Marmon Motor Car Co.

WITH its phenomenal growth, America is calling for technically trained executives in every branch of industry and as executives are usually brought up into the organization from the ranks, it follows that the rank and file of such organization should contain technically trained men, for such a man has an assured future if he is industrious, alert, and grasps the opportunities which continually present themselves in any great organization.

I mention the fact that the leaders invariably come up through the ranks and the technically trained man in the ranks, if he is equally industrious and alert, will be picked in preference to the man who has not had this advantage. I wish to stress the point that I said, other things being equal, the self-made man will always rise from the ranks and become an industrial leader, but he is unquestionably laboring under a considerable handicap which has to be overcome by tremendous effort.

A well trained engineer is one trained culturally, as well as technically. There has been a trend in past years to pay a great deal of attention to the technical training and neglect the cultural training in our engineering colleges, but I understand that this condition is being corrected. It is vitally necessary that an engineer be well groomed for the great battle of life, particularly when he advances in prominence, either in his company, his community, or in technical societies of his particular industry. I have heard college men make miserable failures when they attempted making a speech at a banquet or before great civic meetings in their communities.

Great business today is a battle of brains and the great law of the survival of the fittest affects every worker. I commend good reading to you, as students, and implore you to continue this after leaving college. Familiarity with the classics will give you many an inspiration, make you more resourceful, make you more agreeable with your fellow men and give you an advantage in many an argument, both in the shop and in the board meeting. You may think that you have been compelled to pursue many useless studies, but you will find in later life that you will need all of the information you have obtained in college and a great deal more. Here you are taught to think, and here information is catalogued for you. With a reasonable good memory, you will later put this information into practical use. Of all the studies pursued by the modern engineer, physics, I think, leads in importance, for later as an executive you will be asked to pass on devices and inventions by men poorly grounded in physics, who on that account, have designed mediocre devices and have spent thousands of dollars on the wrong track of endeavor. It is pathetic to meet a poor inventor, presenting a crude, poorly designed device to a great organization, only to be told, as politely as possible, that his efforts have been wasted, due to his total ignorance of fundamental principles of physics. Many of these men, however, are natural born genii and have an uncanny aptitude for designing ingenious devices. The engineer here has to be careful not to give snap judgment on some strange invention, involving principles radically new or unfamiliar to him. We have many technically trained skeptics who do not always contribute prosperity to society.

As a former President of the Society of Automotive Engineers, and with a wealth of practical experience from which to draw, Mr. Litle is well qualified to advise the engineering student as to those phases of his education and those elements of his character which will make for success in later life. As time goes on, increasing emphasis is being placed upon the necessity of an engineer being more than a mere technician. He must be a man able to meet any of the unusual and difficult situations which may arise at any moment in his particular line of work, and with a background of varied experience and instruction, work out a satisfactory solution to the problems. This, we feel, is the true function of our profession, for the routine application of knowledge can do little to advance the sciences and the arts. Only by individual initiative, by being alert to take advantage of every opportunity to do something a little better, or a little quicker than was done before, can we attain success in our chosen field.

I draw your attention to the great German chemical industry, having hundreds of trained chemists in a single plant and as a result, we see wonderful development coming out of their plants. America has had the advantage of great natural resources. Germany has had the advantage of large numbers of technically trained men.

If, after leaving college, you work up in an organization, you will find yourself many times at your wits end for ideas and arguments. The man who has really absorbed and properly catalogued information gleaned at college, has a great advantage over the fellow who some way has just gotten through and probably has forgotten much that he learned.

In the great automotive industry, which covers the manufacture of automobiles, aircraft, trucks and allied industries, the engineer is becoming an important factor. We find him in the president's chair, sitting in with the directors, head of the engineering department, in the sales department and finally directing manufacture.

Unquestionably the engineer is coming into his own in all industry and very high salaries are now commanded by the leading engineers. In the manufacture of automobiles, we have so many diversified interests commanding the attention of the engineer that he becomes, at times, a veritable jack-of-all-trades. He is expected by the management to answer every conceivable question.

An interesting discussion arose one time in a conference at a prominent car company over the construction of the frame of an automobile. I was asked why we did not specify alloy steel in the side bar of the frame, and informed the management that this would be unnecessarily expensive, as the requisite in this case was stiffness against deflection from a given load, and not carrying capacity. An alloy frame might carry the load on a smaller section side bar, but that bar would deflect more under load, causing distortion and probably wrecking the car body. I was forced to back up my argument by a demonstration before the executive group, by placing two bars of steel, of equal section, between two chairs and showing that an equal load suspended from the center of a low carbon steel bar deflected to the same degree as would an alloy bar.

(*Continued on page 310*)

Industrial Possibilities of X-Ray Examination

A critical analysis of the practicability of X-ray methods when applied to engineering and industrial problems

By JOHN T. NORTON, '18
Assistant Professor of Physics
Massachusetts Institute of Technology

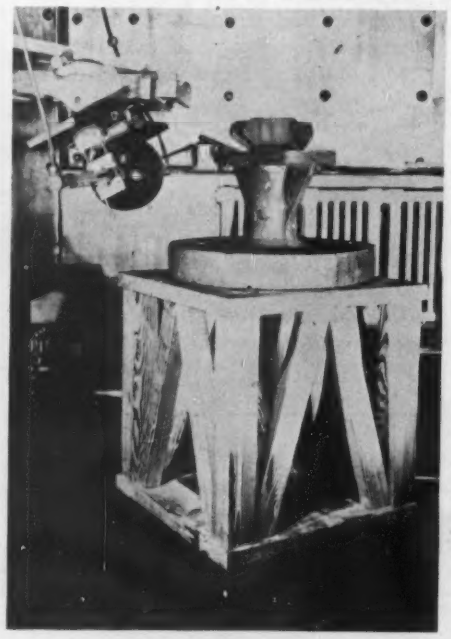
IMPROPERLY ANNEALED
X-ray diagram of a similar steel wire showing failure to remove effects of drafting

DURING the past few years much has been written about the remarkable things which have been accomplished in the various fields of scientific endeavor with the assistance of X-rays. Engineers and industrial people are constantly on the lookout for new developments which will be of value in the particular class of work in which they are concerned and there has been a considerable demand for information about the practicability of these new methods of testing. The purpose of the present paper is to briefly outline the possibilities of X-ray methods and to point out the sort of problem to which they apply and the sort of results which the engineers should expect to obtain.

The practical use of X-radiation is not a new thing and it has been employed for nearly twenty years in certain kinds of work. In the medical field, for instance, it has become one of the most important tools with which the physician has to work and with its aid he can, in effect, render the body transparent and actually observe what are the conditions in the interior. He can also use the radiation with considerable success in the treatment of certain malignant diseases which may be on the surface or deep in the interior of the body. These results are the outcome of much careful and painstaking research and the demands of workers in the medical field have done much to aid the development of modern X-ray apparatus.

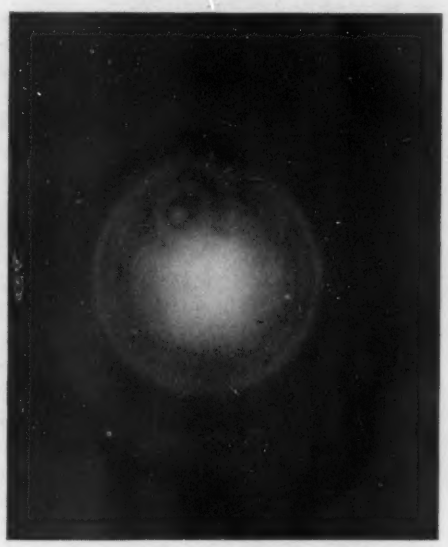
Upon the announcement in 1896 of the discovery of X-rays, there was much interest among students of physics concerning this new type of radiation. This interest has continued to increase until at the present time, there is hardly a physical laboratory of any importance in the world which is not engaged in the study of some phase of X-ray work. The results have been of the utmost importance in modern physics. Not only has it been possible in this way to study the structure of the atom itself and actually count the number of electrons which it contains but also to study the way atoms arrange themselves in solid substances, a factor which, in a large measure, determines the physical properties of these substances.

It is to be expected that the results of these researches in pure physics should find applications to practical industrial problems, and such is actually the case. There are two general ways in which X-rays may be used for



X-RAY APPARATUS
This is the apparatus used by the Massachusetts Institute of Technology to detect flaws in castings. The film is inside hollow casting directly behind area to be examined.

the practical examination of engineering materials. The first of these is essentially of a laboratory sort, that is, it is best carried out in a well equipped laboratory with a specially trained staff. In this respect, these methods are similar to many of the methods of metallographic examination. As a matter of fact, they really belong to this class because their most important applications are to metals. In a general way, these methods may be considered as somewhat similar to the spectroscopic methods of analysis, which are used with visible light, and the following are some of the results to be expected from them in the case of metals.



PROPERLY ANNEALED
X-ray diagram of steel wire indicating perfectly random orientation of grains

X-ray spectroscopy is used to identify the elements which a substance contains. The study of special alloys is a typical example. In the majority of cases, the ordinary methods of chemical analysis would be as satisfactory and much simpler, but there frequently are cases in which, for various reasons, chemical methods are very difficult and the results uncertain. It is in these latter cases that X-ray methods have their application and yield positive indications. In general, this method is only roughly quantitative, but in certain cases where a series of comparison samples can be made, definite quantitative figures will result. The elements are identified by the positions of lines on a photographic film and the quantities are estimated from the intensity of these lines. The details, such as type of sample and time of exposure, vary with each problem so that considerable experience is required to obtain satisfactory results.

In a somewhat similar way, X-rays are used to study the way atoms are

arranged in crystals. All metals are crystalline and this means that their atoms are arranged in a regular and characteristic array. Commercial metals are not large individual crystals but are made up of small crystal fragments packed closely together. X-rays can give much information about the size and about the orientation of these minute grains. These are known as diffraction methods and have become a very important part of metallography.

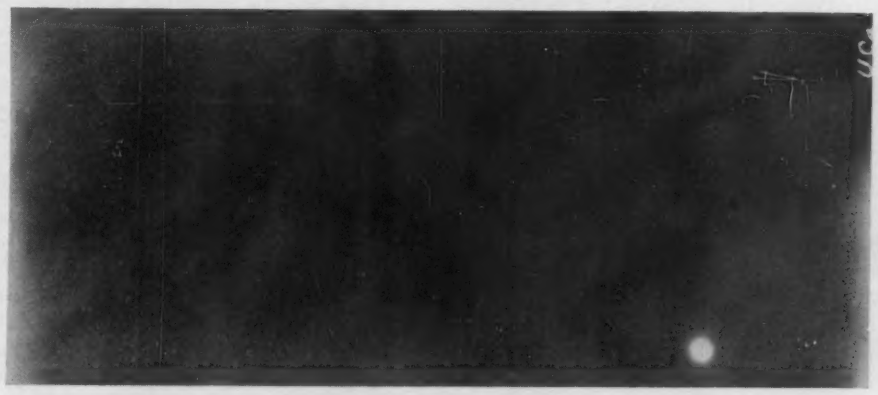
The atomic arrangement in a metal determines, to a large extent, the physical properties. If we desire a metal which is soft and ductile for a particular purpose, we choose a metal which has a particular atomic arrangement. Another arrangement is characteristically hard and tough. This information is of particular value when a metal, as for instance, iron, has several allotropic forms and the diffraction method is a means of definitely distinguishing between them.

Many industrial manufacturing processes involve the cold working and the heat treatment of metals. While this treatment does not change the atomic arrangement, it does alter the size and orientation of the grains with a consequent change in properties such as hardness or ductility. The cold working produces a fine grain with the individual crystals more or less parallel. Heating or annealing of the metal causes a recrystallization and the grains become larger and have a random arrangement.

The drafting of wire is a typical example. The wire passes through dies which result in a severe cold working with a consequent parallel arrangement of the grains. It then passes through a furnace which does the annealing. The process is continuous and the speed of the wire determines how long any element of length remains in the heated area. If it does not reach a high enough temperature or if it does not remain at this temperature long enough to be heated through, the anneal is not complete. This condition can be best studied by taking X-ray pictures of the wire near the surface and near the center and lack of complete annealing can be easily and definitely detected. This information is important in the design and operation of the wire drafting equipment.

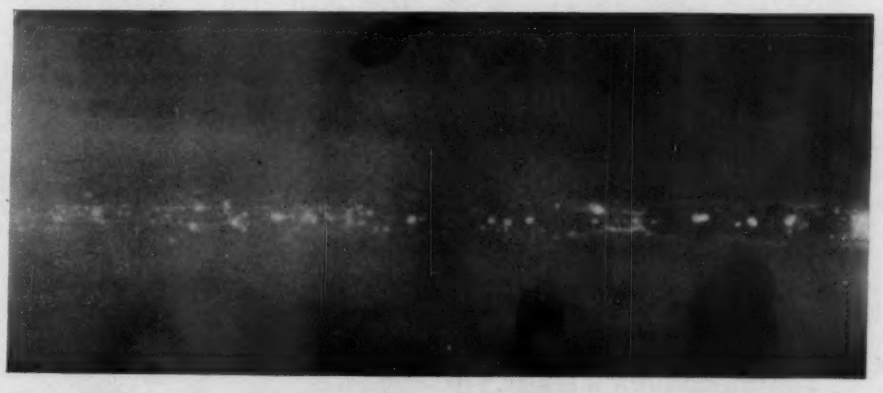
It is evident that different problems require individual treatment so that the X-ray examination should be in the hands of one who has served a considerable apprenticeship. He should not only be familiar with the physics of X-rays and with the general X-ray methods but he must be acquainted with the nature and properties of crystals and with metallography so that he may correctly interpret the X-ray results and alter the procedure when standard methods do not give him the information he desires.

The second way in which X-rays can be of practical assistance in the solution of technical and industrial problems is known as radiography. It is a method of examining in a direct way the gross interior structure of a solid object such as a steel casting or a welded structure. One of the most striking properties of X-radiation is its extraordinary penetrating power in materials which are opaque to ordinary light and it is possible to use this very penetrating "light" to take shadow pictures of the inside of things which we cannot see through. This method has been practical in the medical field for a number of years but equipment of considerably higher power was needed to penetrate the very much more dense materials of engineering. This equipment has been gradually developed to the point where it is now possible to examine steel up to a thickness of about four inches and one can detect such defects as gas pockets, sand or other inclusions, and shrinkage cracks whose dimensions are greater than about two per cent of the total thickness. The limit of thickness in brass is somewhat less and in aluminum and its alloys considerably more because the penetrating power of the rays is largely dependent upon the density of the material. The pictures are generally recorded on photographic film, although in certain special cases visual results are possible. However, the equipment and technique is well standardized so that it is now possible to say quite definitely what can be expected in the way of information about a particular problem.



SATISFACTORY WELD

The radiograph shows uniform section throughout



POOR WELD

The white spots indicated by radiograph are inclusion of gas and oxide. Dark black spots are surplus metal dropped on surface by welder

Naturally the engineer wishes to know just how practical is the use of radiography. The answer to this depends entirely upon the sort of problem involved. If he is the manufacturer of automobiles, he has little need for the sort of information which X-ray methods supply. Of course this does not apply to the very large companies or groups of companies who are maintaining an extensive research program. But the average manufacturer follows very definite specifications laid down by successful practice. On the other hand, the manufacturer of high quality steel castings has a very definite need for this type of information. Quality castings are chosen to meet unusual conditions, where safety factors cannot be made extra large and where failure would be very serious. Such a

(Continued on page 308)

The Industrial Application of Microbiology

The use of living material to promote and control chemical changes

By SAMUEL C. PRESCOTT '94
Professor of Industrial Biology. In charge of Department of Biology and Public Health
Massachusetts Institute of Technology

IN an article entitled "Bacteria — the Smallest Workers in Industry," contributed to THE TECH ENGINEERING NEWS, by Dr. B. E. Proctor of the Department of Biology and Public Health of M. I. T., it was pointed out that many processes of immeasurable importance to mankind are dependent on the activity of countless microbes. Those working in soil or in specially prepared substances, yield, through their power of transforming materials, products which are of great service in agriculture or industry.

It may be of interest to readers of the present volume to get a glimpse of the breadth of the extending field which modern bacteriology is spreading out before us in applications of bacteria and fungi in industries rather than in their relation to the problems of health and disease in man and other animals. Publicity regarding bacteria and disease has been so much greater, and from the individual standpoint so much more important, that the mention of microbes at once awakens in the mind of the average citizen — "the man in the street"—visions of sick rooms and hospitals, of diseases and suffering, from the common cold to the pestilence which may be alarming in its fatality. But there is another more favorable and equally interesting phase of the significance of germ life, their applications in industry, which taken together are the basis for the applied science of Industrial Microbiology.

For generations on end man has utilized microörganisms, sometimes unwittingly, in the preparation of many of the necessities or luxuries of life. In the preparation of our simplest and most widely used foods, bread and butter, they have for centuries played an important part. So long as the production of these staple foods were purely domestic operations, the significance of the microbe was not emphasized, but with the modern development of food industries and the change from domestic or small scale operations to factory processes on an enormous scale, the indispensable microbes have taken on new importance. The same is true in the production of those beverages, wine and beer, which in literature if not in fact, have so often been the liquid accompaniments of the simple foods mentioned throughout the greater part of the world. It remained for modern science to discover many more ways in which the invisible hosts of microbic life participate in industrial processes, or to harness these infinitesimal organisms to serve man as agencies of chemical change.

This, in its multiple ramifications, is the work of the industrial microbiologist. He must be equipped not only with a comprehensive knowledge of the microbes themselves, but must also understand the physics and chemistry of the materials with which he works, and particularly that chemistry of the products and activity of plant and animal life which we call biochemistry. Thus fortified, he may be able to solve many of the hidden processes of nature, and to select, develop and intensify some of these processes into economically productive and profitable industries, or he may be able to exert such restraining influences that destructive action may be prevented. The industrial microbiologist visualizes always the two opposing potentialities of microbes, one that they may exert destructive action on materials which it is desired to conserve, the other that they may transform materials into products that it is desirable to prepare in large quantities. The general application of microbiology to the food conservation industries is an example of the first class; the development of special fermentations yielding desired substances is an example of the second class. As a matter of fact, both aspects of the problem may be intermixed, for in the development of a special fermentative process which may be of great value, the microbiologist must be eternally vigilant to prevent the incursions and the destructive action of undesirable organisms.

Although the number of men enrolled in the courses in Biology and Public Health is not particularly large, this department has made an enviable record for itself in maintaining the standards of the Institute, both in the quality of the research it performs and in the records of its former students. Dr. Prescott has written an exceedingly interesting article from a non-technical point of view, discussing the industrial applications of the work of his department. In a subsequent issue, we plan to publish an article with regard to the public health and human welfare side of its work.

The fundamental conception of industrial microbiology, like that of infectious disease, is that for each type of biochemical change there is a specific organism or group of organisms which activate and carry on the process. Thus yeast has long been recognized as the specific producer of ethyl alcohol, just as the anthrax bacillus is the cause of splenic fever, or the typhoid bacillus of typhoid fever. In fact, the *specificity* of organisms was first worked out by Pasteur in his notable studies on fermentation processes and was later proved to be equally true for the so-called germ diseases.

In industrial processes involving the use of microörganisms, the microbiologist must control his living material even more carefully than the chemist watches his reactions. In the first place, of course, he must have the right kind of microbe, for some bring about chemical changes which others do not. Further, he must have the right species or even a certain "strain" of that species for best results. For instance, some yeasts do not produce alcohol, but break it down; others neither produce it nor act upon it, while still others produce either large or small quantities from a given amount of sugar. Thus it is of the greatest importance to find out all about the microörganism itself. Then the environment must be carefully controlled — the H-ion concentration of the medium, its temperature, the amount of moisture present and in many cases the amount of air, being all-important factors. Finally, the right kind of food must be available, since microörganisms are often very particular in this respect. Some kinds may act upon proteins, while others do not; one may thrive upon fats, and another will not even grow on them; a species of yeast may have absolutely nothing to do with one kind of sugar, while another species rapidly reduces it to alcohol and carbon dioxide. Thus the microbiologist has a peculiar problem all his own — the biochemistry of fermentations.

It may now be of interest to enumerate and discuss briefly some of the problems or processes which fall in the field of the industrial microbiologist. These may be grouped conveniently into the two classes of *productive* and *preventive* processes — involving either bacteria, yeasts or molds:

1. Productive processes of Fermentation: (*a*) industrial alcohol (ethyl

alcohol); (*b*) acetone; (*c*) butyl alcohol; (*d*) glycerin; (*e*) lactic and citric acids; (*f*) manufacture of yeast; (*g*) acetic acid and vinegar; (*h*) manufacture of food products such as bread, butter, cheese, sauerkraut, soy-sauce, fermented milks, and silage for animal feeding.

Closely related to these are the applications of bacteriology in leather making, retting of hemp and flax, the preparation and use of nitrogen-fixing organisms, and the action of microbes in certain types of water purification and sewage treatment.

2. Preventive Processes: (*a*) food preservation; (*b*) wood preservation; (*c*) protection of fibres and textiles; (*d*) manufacture of sugar; (*e*) preparation of fruit juices and beverages; (*f*) use of disinfectants and fungicides.

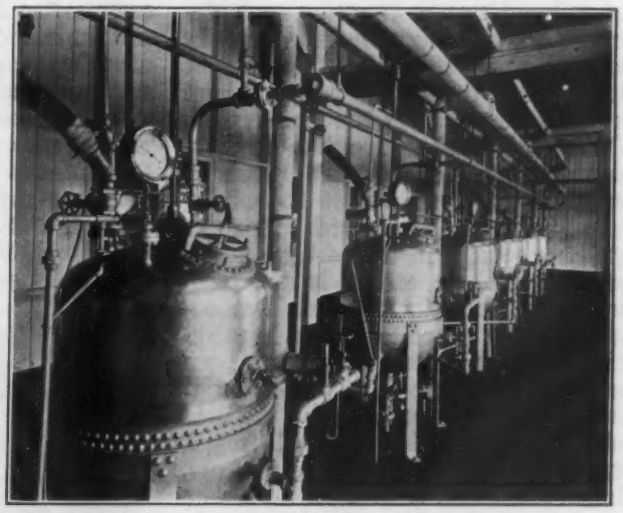
These lists might be considerably extended, especially if one were to include the many phases of agricultural application in soil treatment and crop protection, and the commercial production of the numerous antitoxins, vaccines, sera and special products used in human and veterinary medicine.

Industrial ethyl alcohol has been produced for a good many years by the fermentation of sugars. Molasses is at present the chief source of raw material for this purpose. Substances containing a large amount of starch, such as potatoes and corn, are also used. The use of these involves the additional, but in certain parts of the country, economically practicable step of first converting the starch to sugar. Thus surplus or unmarketable foodstuffs may be converted into a marketable commodity. Even waste products such as sawdust, wood-pulp liquor and other cellulose or sugar containing materials have been used in some countries. It is claimed that the Nipa palm of the Philippines furnishes the cheapest raw material in the world for alcohol manufacture, and that the Philippine Islands could furnish 50,000,000 gallons of alcohol annually from this source alone. The time will probably come when it will be not only desirable, but necessary to use such natural and waste products for making industrial alcohol.

Previous to the World War, the acetone of commerce was produced by the destructive distillation of calcium acetate, but with the increased demand fermentation processes were developed. Several types of bacteria have been used to ferment the carbohydrate materials. Ethyl alcohol is produced in quantities three to five times that of the acetone, together with small amounts of other alcohols, but the yield of acetone is high enough to make the method feasible. Since the war the demand has fallen off, so that fermentation processes are of less industrial importance.

Of the processes of the first class above, probably the ones dealing with butyl alcohol and glycerin are of the most interest at the moment, as they are the most recent to be advanced to the position of becoming basic industries. Both of them owe their development to the war demand for products which could be utilized in the preparation of munitions, but the fundamental observations on which the research leading to the industry is based antedate by many years the actual attempts to turn these bacterial processes to economic account.

It was Pasteur himself who noted that in the production of alcohol by yeast there was the formation of a trace of glycerin, while the first observation that butyl alcohol may be produced by bacteria was by Perdix in 1891. Statements in books of the period mention these discoveries as interesting and curious facts, but they add that "they have no technical significance." Today there are several large plants engaged in the production of butyl alcohol by fermentation, and it is an important chemical in the production of photographic film, lacquers, "Duco," and a great and increasing variety of technical products. The fermentation takes place in converted starch or sugars, is practically carried out under anaerobiosis and is extremely sensitive to physical conditions, concentration, H-ion concentration, etc. The organisms responsible for such fermentations constitute a group to which the name *granulobacter* has been applied, as they are not uncommonly found on grains, bran, and products of milling as well as in the soil. The great plants of the Commercial Solvents Co. and the control of their process of manufacture were described in the Journal of Industrial and Engineering Chemistry in January, 1927. A new organism was worked out in the laboratories of the Department of Biology and Public Health in 1926 by Morikawa, and was found to produce isopropyl as well as butyl alcohol.



Courtesy of *Industrial and Engineering Chemistry*

CULTURE VESSELS USED TO CONTROL MICROBE GROWTH

In these autoclaves, the microörganisms which convert starch into butyl alcohol and acetone multiply rapidly

Courtesy of *Industrial and Engineering Chemistry*

FERMENTATION TANKS FOR COMMERCIAL SOLVENTS

In one plant, forty-eight of these 50,000-gallon fermenters bring about the final conversion of corn into organic solvents

Fermentation glycerin has not had as continuous a history of development. For many years the soap industry could supply practically all the glycerin needed in arts and manufactures. The demand became enormous during the war and prices rose to unheard-of heights. This stimulated research in the fermentation field, and a method of fermentation was elaborated by Eoff in the Internal Revenue laboratories in Washington and patented for the people, in order to avoid the possibility of monopoly. The cessation of the war lowered the price of glycerin again and its production by fermentation ceased to be economically advantageous. Recently, however, it has again become industrially significant.

The organism involved in this fermentation is yeast, of which a number of types may be employed. To secure

(*Continued on page 302*)

The Coöperative Course in Railroad Operation

Now a year old, this course offers unusual opportunities to those interested in the transportation industry

By JOHN B. BABCOCK '10
Professor of Railway Engineering
Massachusetts Institute of Technology

MANY important changes have taken place in the field of transportation since the return of the railroads in 1920 from federal control to private management. The rapid development of highway transportation has changed the character of railroad traffic, resulting in a decrease in passenger business and in local freight traffic. The total freight tonnage and the average length of haul have increased during the same period. One railroad executive has recently described it as a change from the wholesale and retail business to the wholesale business. To furnish adequate rail transportation it has been necessary to increase car loads and train loads, to maintain faster road schedules and to expedite terminal operations. At the same time it has been necessary to meet the competition of automotive transportation in the field of passenger and short-haul freight traffic by the use of gasoline rail cars, buses and motor trucks.

The development of fast freight transportation has required the adoption of more powerful locomotives, the strengthening of tracks and bridges, and the construction of improved yards and terminals. Railroad executives have had other problems not directly connected with traffic movement, such as the installation of automatic train control in accordance with the requirements of the Interstate Commerce Commission, and the elimination of grade crossings.

The establishment of a course in Railroad Operation within the past year by the Institute in coöperation with the Boston and Maine Railroad was in recognition of the increasing importance of an engineering training as a background for those who are to enter the field of railroad transportation. The object of the course is to provide fundamental training in the principles of modern science and practical experience in the operating department of a progressive railroad. Competent young men, who have the ambition to become railroad operating officers, will receive a training which will help to develop them for responsible positions in the transportation, motive power, and engineering departments. Emphasis is placed on the operation, extension and improvement of existing lines, rather than on the construction of new lines; on economical operation of freight and passenger transportation by the use of modern methods and equipment; and on auxiliary means of transportation. Those basic subjects are included which are essential to the understanding of the problems in civil, mechanical and electrical engineering met with in railroad operation.

The course in Railroad Operation is a five-year coöperative course leading to a Master's degree. After the first two years, which are spent at the Institute, the students alternate between the Institute and the Boston and Maine Railroad. The subjects of the first and second years are practically identical to those taken by other engineering students. In the summer following the first year, students attend the Summer Surveying Camp near East Machias, Maine, for about eight weeks. The original schedule also included several other courses to be taken during that summer, but the program has now been changed so that these are taken during fall or spring terms. The course is conducted in much the same way as the coöperative course in Electrical Engineering, which has been functioning successfully at the Institute for a number of years. After the second year, the students are divided into two groups, one group taking studies at the Institute, and the other working at the Railroad. Students while on coöperative work attend two evening classes each week at the Institute. Practical experience is obtained in the following departments of the Railroad: Maintenance of Way (including Signals), Maintenance of Equipment, Conducting Transportation, and General (including Accounting, Stores, etc.).

PROFESSOR JOHN B. BABCOCK

At the present students are registered in the first three years of this course, which was established in February, 1928. The students in Group A, third year, are now with the Mechanical Department of the Railroad. The work of each student is scheduled in detail for the entire eighteen-week period so that he can take part in all of the important operations in that department. The following schedule for one of the students indicates the scope of his work in the Mechanical Department: locomotive shop, 4 weeks; signal department, 2 weeks; engine house, 3 weeks; car shop, 2 weeks; mechanical engineer's office, 3 weeks; locomotive operation, 3 weeks; mechanical superintendent's office, 1 week.

Students on coöperative work are not "visitors"; they are paid employees and do their share of the actual work. They do not, however, remain on one job long enough to become skilled mechanics. It is not the purpose of the course to train apprentices for some particular department, but rather to give them a working knowledge of all the operations in that department. For example, a student is assigned to the locomotive shops at Billerica, Mass., for four weeks; while there he works at least one day on each of a dozen or more jobs that are involved in the heavy or so-called "classified" repairs of a locomotive. Although he does not become mechanically proficient in any of the routine operations, he has an excellent opportunity to grasp the essential features and to get a coördinated view of the work of the locomotive shop. Similarly, after three weeks' work in an engine roundhouse, a student will become familiar with the maintenance of a locomotive from the time the engineer turns it over to the "hostler" until it goes out on the next trip.

The work in the Mechanical Department has been described in some detail because the students are on that particular schedule at the present time, but the method of carrying on the cooperative work will be substantially

(*Continued on page 314*)

Editorials

SIGNPOSTS OF THE AIR

The Daniel Guggenheim Fund for the Promotion of Aeronautics has requested us to announce through our editorial pages the opening of a nation-wide campaign for the identification of towns and cities from the air. The movement is being supported by the Government Departments of the Navy, War, Commerce, and the Post Office Department, and the coöperation of the major industries of the country is urgently requested.

Identification under the proposed plan consists of a system of standard roof markings. These are to be placed on a prominent building in each community, as for example, a large building of an industrial corporation. Many of the organizations of the latter type throughout the country have already coöperated in this respect. Those having available roof space in unidentified communities are urged to communicate as soon as possible with the Post Office Department and obtain information regarding the standard form of markings that have been adopted.

We hope that the members of the engineering profession will realize the importance of this project and direct their efforts accordingly. The existence of aviation was made possible only through the advances of science and engineering. It is now necessary that science and engineering step in again to make it a safer and more efficient tool of commerce.

SPECIAL LECTURES

Hardly a day passes in our Institute life without a special lecture delivered by some prominent visitor at Technology in regard to the particular subject in which he is an authority. Recently, the main lecture hall was packed upon two occasions, within a few days of each other, with different speakers upon entirely unrelated subjects. The first speaker was Mr. Clarence Darrow, the noted criminal lawyer who has figured in numerous cases of nation-wide interest; the second was M. Georges Claude, one of the greatest French scientists, who has been in this country to attend an international fuel conference recently held in Pittsburgh.

We are glad that a large portion of the student body was able to cut their various lab classes, drill, or postpone their three laps around the track in order to hear Mr. Darrow. As one of the modern school of thought in matters of religion and human relations in general, his ideas are worth hearing, whether we find ourselves able to agree with him or not. That so great a number of students took an interest in what he had to say is a sign of a healthy undergraduate interest in the affairs of the world beyond our narrow sphere of books and classes, a realization and a desire to assume the burdens and responsibilities of citizenship in the world of today.

M. Claude's lecture, the following day, received an equally large attendance. His subject of "Power from the Sea" is one which would appeal to a person engaged in the study of engineering problems, for this has long been a goal toward which many have turned their efforts. From his wealth of experience in scientific endeavor, he presented a talk which greatly impressed the majority of his audience.

THE COVER

"The Pillar" is the title of the etching by Mr. O. Kuhler which has been chosen as our cover illustration for this issue. We have had the pleasure of using several examples of this artist's work on the covers of previous numbers of The Tech Engineering News, *and we look forward to others of the same general nature in the future. These etchings are obtained through the courtesy of the Schwartz Galleries, New York.*

Such a lecture would not have been given under any of the courses now presented at the Institute, but, as a special feature, was made available to the entire student body, and their interest showed that his coming was well worth while.

These special lectures from time to time, can do much to broaden one's education while at school. The policy of the Institute in securing scientists of high calibre is to be highly commended, and the work of the Liberal Club in arranging for speakers, as was done in the case of Mr. Darrow, deserves whole-hearted encouragement and support.

AN ENGINEERING MUSEUM

One of our featured articles in this issue is that of Dr. F. C. Brown on "The Industrial Museum as an Aid to Technology." We feel that the ideas suggested by the author and the project presented in the article are worthy of the support of all those interested in the advancement of science and the engineering professions in America.

Although the United States abounds in museums devoted to ancient history, the fine arts, anthropology, geology, and natural history, nowhere exists in it a museum devoted on a large scale to industrial engineering. This is indeed a curious situation, for Great Britain and continental Europe possess several very complete ones.

The United States is the industrial leader of the nations. She has done more for the advancement of applied science, for the advancement of engineering, than any other one nation. Her industries employ more men, they serve more people, they assume vaster proportions than in any other country. Nevertheless, the average man is left in ignorance of the how and why of many of the great industries.

An engineering museum would go farther toward educating the average man than any other means. He would rather see than read or hear. He wants to see before him the machinery, the methods used; he desires to watch them at work, rather than to wade through a dry technical description.

That people would support such a museum is evidenced by the Open House program of Technology. For one day every year the Institute is turned into a vast museum. On exhibit are the products of the labors of teachers and students, past and present. They represent perfected methods; they represent methods in the bud. The Open House attracts many thousands of visitors each year. That the interest of the majority of visitors is genuine the writer can affirm, for, as a guide, he has been rather hard put to answer some of the searching questions the visitors asked.

Fortunately, the attention given this question of an engineering museum is constantly increasing. With a modest beginning, the Museum of the Peaceful Arts in New York is already well established and expanding as rapidly as conditions will permit. Plans have been made in Chicago for a museum which will rival those of Munich and Vienna, and the National Museum at Washington contains an increasing number of exhibits suitable to an engineering museum.

Here at the Institute, in the exhibits of products and processes furnished by various industrial concerns, we have the nucleus of an engineering museum of our own. Certainly such an institution should have a place in the leading technical school of the country. It would serve as a valuable aid in many of the courses of instruction, and would be a source of inspiration both to the student body and to those visiting the Institute from the outside world. We would welcome comment on this idea from our readers, for we feel that this subject is worthy of consideration in the future plans of Technology.

The Engineering Field

Abstracts from the leading professional and trade journals

Parking automobiles in a crowded city has been simplified greatly by a new device introduced by a western inventor which simply jacks the rear wheels up and rolls the rear end of the car towards the curb by means of castor wheels propelled by the transmission of the motor.

To raise the rear wheels from the ground an oil hydraulic pump operated from the engine straightens out two pairs of toggles. The castor wheels are mounted on shafts which are pivoted on the car frame a short distance behind the transmission, and when the rear end of the car is raised a gear on the end of the right hand shaft, which is closer to the central shaft, meshes with a gear of the transmission in low gear. When the gearshift lever is set in forward low speed, the rear end of the car moves towards the curb, and *vice versa* if the gearshift lever is set in reverse speed.

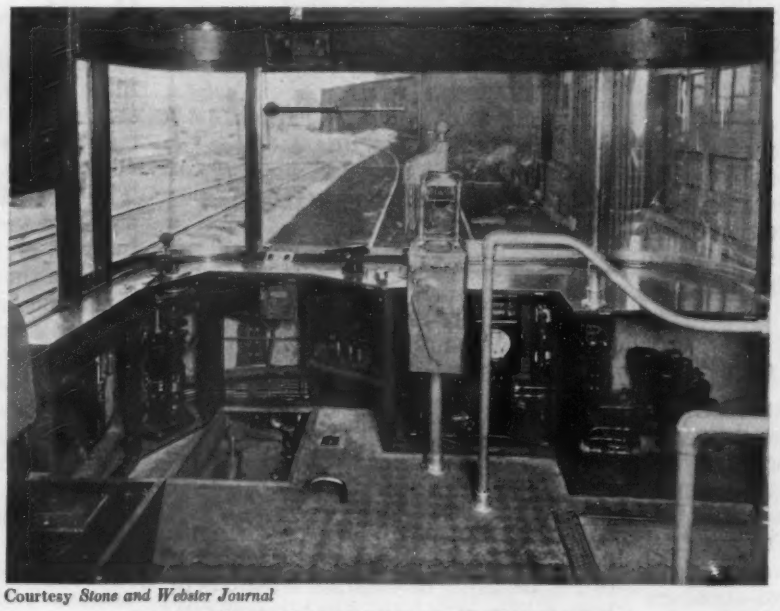
Having the driving shaft closer to the central axis of the car gives more traction to the driving castor, and in addition, if the road is crowned the traction is further increased. Then when the rear end is raised the rear wheels move, and the car brakes may therefore be applied. When the castor wheels are not in use the toggles hold them as high from the ground as the height of the center of the rear axle.

Bridge Spans were erected on the Arkansas River by an ingenious method of building the trusses on shore and floating them in place, because of the danger of floods which make it necessary to work with the least possible amount of falsework.

The first step in the erection of the 2,000-foot bridge was to construct a loading dock some 400 feet upstream, made up of two trestle runways running out into the river. The spans were constructed between these trestles, and two barges, partly submerged and carrying trestles, were floated under them. When the water was pumped out of the barges, the bridge span was consequently raised from the loading platform, and the barges carried the span to its proper location on the piers in the river.

The barges were controlled entirely by two boilers and two three-drum hoists on one of the barges, with control cables attached to pile dolphins stretching across the river upstream from the loading dock, and finally with auxiliary control cables fastened to anchorages below the bridge site to bring the truss in proper location between the piers. When in proper location, the barges were partly submerged and the truss span left resting on the piers while the barges floated back for another span. The whole operation took only six hours for each span.

The Birney Street Car recently designed and built has many improvements over those now in use. Its light weight and its relatively vibrationless, noiseless operation make possible greater comfort at higher speeds and at the same time decrease cost of operation.



Courtesy *Stone and Webster Journal*

FRONT PLATFORM OF THE BIRNEY CAR

The first step toward decreasing weight was to replace the usual noisy and massive trucks with four light disk wheels. The location of these wheels near the ends of the car prevents side sway and "rocking," and because of rubber pads between hubs and tires, cushions are provided which absorb noise and vibration. This decrease in weight and the lessening of vibration, due to use of rubber inserts throughout construction, make possible a further lightening of superstructure. With the addition of a noiseless air compressor, the ultimate in silent operation is attained.

Leather upholstery in chair-like seats, harmonious coloring and lighting, and attractive paneling over control mechanism, make the interior look more like a bus than street car, an effect which is produced also on the outside by the use of an automobile type bumper. Not to be overlooked is the increased safety afforded by complete visibility in all directions from the front of the car through large plate glass windows.

Water Purification is being accomplished by a new method of treatment using ozone, which experts decree to be the best and safest of all the commercial methods now in use.

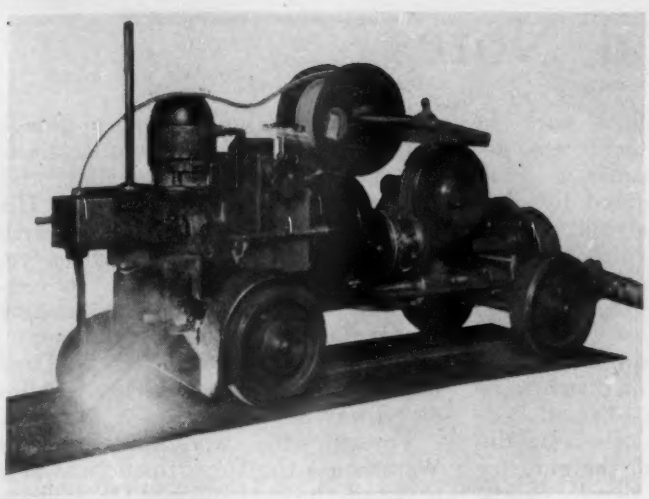
The ozone is produced by the action of an electric brush discharge which occurs when an electric current is passed between two electrodes through an air gap and a dielectric. By this method oxygen is converted to ozone. This reaction is characterized by a peculiar noise, blue-violet colored sparks, and the phenomena known as the electric wind.

The apparatus is used to take dangerous bacteria and foreign odors and colors out of drinking water. It will also oxidize any organic matter which may have gone into the water during its journey through the earth. In addition, the apparatus may be used to purify and deodorize air.

An Automatic Arc Welder of the tractor type has been put on the market by an Ohio electric company. It utilizes the electronic-tornado principle and is used in making lap welds on large tank bottoms, roofs, and similar work.

The machine consists of an electronic-tornado head supported on a self-propelled four wheel drive carriage. The machine is put into operation by placing it over the piece to be welded and starting the arc to which the current is fed by a flexible cable. The electrode and fibrous autogenizer are automatically fed as the tractor travels forward.

The chief improvement of this machine is the speed at which it operates. One-fourth of an inch arc welds are



Courtesy *Marine Engineering*

THE AUTOMATIC ARC-WELDER

made at the rate of fifty to seventy-five feet an hour. When this device is used for lap welds no filler is needed for the high heat of the carbon arc fuses the edge of the top plate into the lower plate making a leak-proof joint.

New Design Track construction is part of the program of street car track and paving reconstruction now in progress in the city of Buffalo. Smoother and cleaner streets are among the advantages resulting from its use, and street car noises are considerably lessened.

The most important feature in which the new method differs from common practice is the elimination of block-stone between the rails. A concrete base is used instead, with a surface of asphalt. Steel ties and heavy rails complete a work of the most improved type.

A Pot Testing machine for testing the uniformity and balance of pot wheels, used in the manufacture of rayon silk, has recently been introduced on the market.

The machine is constructed of heavy cast-iron, and is run by an electrical motor with a reversible oil switch and pyrometer. Having the pot enclosed in a heavy chamber, with only a long hole through it, the operator may watch the performance of the pot, and when he sights any vibrations in a pot or on the pyrometer, he immediately stops the machine by means of an oil reversible switch, and has the correction made.

It is absolutely necessary to have the pots perfectly balanced and to revolve evenly at 6,000 r. p. m., for if a pot vibrates, the rayon is stretched and an uneven cake is formed from which the yarn cannot be evenly wound. This machine tests pots in a minimum of time, with a minimum cost of operation, and with scientifically accurate results. Its most important feature is its protection of the operator and the motor.

Steel-Tank Mercury Rectifiers are replacing rotary converters for heavy duty railway and power service. A western power company uses two of these units, placed at 750 kw., 1,400 volts, 535 amp., to serve a trolley feeder system, and these rectifiers make possible a change from the thirty-three cycle system of the company to the sixty cycles required by the railroad.

A small motor generator furnishes the power required to strike the arc, and an automatic relay connects this arc when the load current falls down to 100 amp. The tube tank is water-cooled, and the unit is kept under a constant vacuum by a motor-driven vacuum pump. Operating under light loads, the anodes are kept at the required temperature by separate heaters, but when full loads are carried these heaters are cut out. There is also an automatic safety cutout device which is directly connected with the gates of the cage surrounding the rectifier. On opening the gate this device immediately de-energizes the equipment.

The important characteristics of this rectifier are lack of any rotating parts, absolutely quiet action, high instantaneous overload capacity, absence of synchronization, lack of polarity mistakes, and no necessity for regulations of voltage and power factors.

Two Gigantic Dirigibles, the ZRS-4 and the ZRS-5, each nearly twice the size of the "Graf" Zeppelin, will take the air in 1931 for use in the United States Navy.

The American dirigibles will have many new design factors that will make them unique. Due to the use of inert helium instead of inflammable hydrogen for inflation, it will be possible to place the engines inside the hull. The internal engines will allow the ship to slip through the air with much less resistance, and there will be less danger of the engines being torn off in storms. The framework, being made of duralumin, a light but unusually strong metal, will have a strength unequaled in any other designs.

Every portion of the frame will also be close to the corridors and passageways, thus making it readily accessible for inspection and repair even during flight.

Diamond Pointed Tools have been used for years in cutting hardened steels and other materials for which steel tools would be too soft. They are now replacing steel tools for cutting materials which although they are soft are difficult to work with steel tools and dull them rapidly.

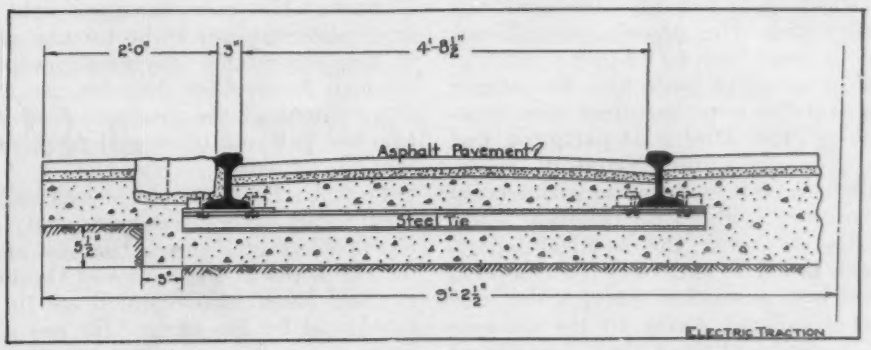
Two types of diamonds are used for tool points. Those coming from Brazil, known as carbons, are the more satisfactory because they are less liable to fracture than the imperfectly crystallized tools.

Anthracite Coal of an unusual high quality is being introduced by a Boston supply concern. It is claimed that through its use greater economy in heating operations may be obtained. Although its cost is somewhat higher than that of ordinary fuels, this is counterbalanced by the increased efficiency with which it may be converted into heat. The coal is mined in the Jeddo, Pennsylvania district.

Values for the characteristics of the new coal as obtained from analysis are given below together with the average values for the fuels now in general use.

	New Coal	*Average*
Volatile Combustible Matter	6.97%	3.79%
Fixed Carbon	87.60%	83.95%
Ash	5.43%	8.29%
B./T./U. Per Pound Dry Coal	13,970	13,612

It may be observed from these figures that the new coal is decidedly superior in all important respects.



Courtesy *Electric Traction*

CROSS-SECTION OF NEW TRACK CONSTRUCTION

Departmental Notes

DEPARTMENT OF MINING AND METALLURGY

Prof. W. Spencer Hutchinson, the head of the Department, was called to South America on an important piece of professional work just at the beginning of the term. He left Boston on September 24, having received a leave of absence for the first term. He expects to be back the latter part of January. During his absence, Prof. R. S. Williams is serving as acting department head.

The most important physical change in the Department was the transfer of all of the laboratory apparatus and activities of the Physical Metallurgy from Building 5 to Building 8, which means that this very important and rapidly growing branch of metallurgy is now closely tied in with the entire department, and all of the members of the staff have a better contact with one another. The space made available in Building 5 will be used by the Department of Mechanical Engineering for the expansion of its work in mechanical testing. The space in Building 8 was made available by an exchange of space with the Chemical Department. Originally, the fourth floor of Building 8 of the Mining Department was laid out very carefully to take care of the future needs of the Department in metallography, heat treatment and testing, but the needs of the Chemical Department for space caused this fourth floor to be given over almost entirely to that department after it had been used by the Mining Department for only a short period. At the time this seemed to be the best solution because there was space available for this metallurgy in Building 5, but now the time has come when the physical metallurgy has to come back to its proper place in the department building. In making the transfer some sacrifices were inevitable. The Mining Department had to give up some laboratory space, which leaves it temporarily without any laboratory facilities for chemical work. In the same way, the chemical department found it necessary to compress itself into a smaller space, which was rather difficult owing to the increase in graduate work of that department which called for enlarged operations.

Looking toward future work in Physical Metallurgy, there was acquired during the summer a 3-ton Nacel air hammer operated by electricity. However, this will not be set up until its final location has been decided upon.

Prof. H. T. Mann, who is in charge of the petroleum option of Course III, spent much time during the past summer in making a trip through the oil fields of Oklahoma, Texas, Louisiana and Arkansas in order to maintain a close contact with the industry and learn of the latest developments. This new petroleum option will fill a demand for men trained in oil production methods.

The Department options have been renumbered so that the old Option 2 of production metallurgy has now become Option 3 and the petroleum option is now Option 2. Option 1 still remains as the general mining option. The fourth option is that in physical metallurgy which went into effect this year and is already finding some enrollment of undergraduate students. However, the great field of this option appears to be to take care of the instruction in metallography for men from other departments and also to instruct the graduate students who are entering more and more into this line of work.

THE SUMMER MINING CAMP GROUP

Prof. G. B. Waterhouse was called upon to act in an advisory capacity on the problem of securing the best steel for the wires in the cables of the new Hudson River bridge which are to be fabricated by Roebling. He has also been doing expert work in connection with the process of direct reduction of iron from ore, and the uses of sponge iron. He attended the October meeting of the American Iron and Steel Institute in New York City. His previous paper on basic open hearth practice before this organization received favorable comment. In connection with the new coöperative course of the Civil Engineering Department with the Boston and Maine Railroad, he has been giving lectures on railway maintenance.

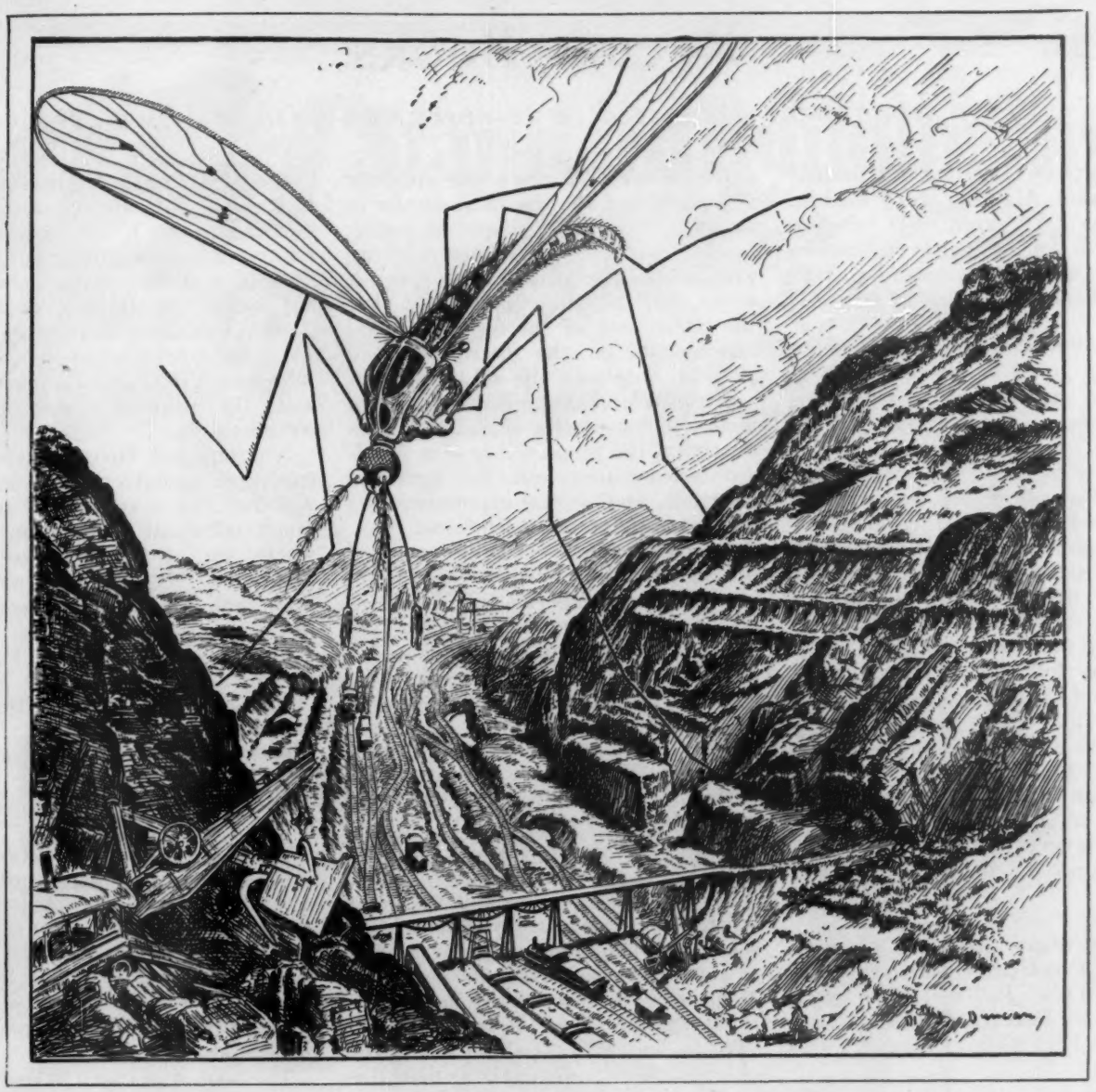
Through the work of Professor Waterhouse the Department was able to obtain the distinguished Dr. William H. Hatfield, Director of the Brown-Firth Research Laboratories in England, to give three lectures: one on November 8 on the applications of science to the steel industry; one in the afternoon of November 9 on rust and acid resisting steels; and the third that evening on cast iron. The first two lectures were primarily for Technology students; the third was sponsored by the Boston Section, American Society for Steel Treating joined with the New England Foundry Men's Association. Dr. Hatfield is a recognized authority on stainless steels and, it is interesting to note, incidentally, that he was a classmate of Professor Waterhouse at Sheffield, England.

Prof. C. R. Hayward conducted the metallurgical trip of undergraduate students during the week prior to the opening of school. The class saw the mining, concentration and blast furnace smelting of iron ore at Lebanon, Pennsylvania; the manufacture of steel at Bethlehem; zinc smelting at Palmerton; copper smelting at Carteret; and lead smelting at Perth Amboy.

The Summer Mining Camp was carried on successfully under Mr. W. C. Eberhard and Mr. F. L. Foster at Dover, New Jersey, with an increase in the number of students.

The rapid growth of geophysical prospecting for ores and oil has necessitated the introduction of this subject into the curriculum. This year a course of forty-five hours is being given by Mr. F. L. Foster, who has been especially training himself along this highly technical line. Mr. Foster spent the past summer in Newfoundland doing practical work along

(*Continued on page 306*)



...but a mosquito blocked the way

THE Panama Canal diggers had engineering brains and money aplenty. But they were blocked by the malaria and yellow-fever bearing mosquitoes, which killed men by thousands.

Then Gorgas stamped out the mosquito. The fever was conquered. The Canal was completed.

The importance of little things is recognized in the telephone industry too. Effective service to the public is possible only when every step from purchase of raw material to the operator's "Number, please" has been cared for.

This is work for men who can sense the relations between seemingly unrelated factors, men with the vision to see a possible mountain-barrier in a mole-hill—and with the resourcefulness to surmount it.

BELL SYSTEM

A nation-wide system of 18,500,000 *inter-connecting telephones*

"OUR PIONEERING WORK HAS JUST BEGUN"

Recent Books

This department conducted in co-operation with the faculty

Elements of Qualitative Chemical Analysis, A Laboratory Guide. By WILFRED W. SCOTT, Sc.D., *Professor of Chemistry, University of Southern California. D. Van Nostrand Co., Inc., New York, 1928. Price $1.60. 164 pages.*

This book is to be recommended as a laboratory guide in the elements of qualitative analysis for a short course, but for a short course only, as it is not sufficiently comprehensive for a very thorough or complete treatment of the subject. It is well written, well planned, and has several desirable features.

The introduction, which deals with laboratory manipulation, is a good idea and might well be carried farther in a large book. The charts for each group should help to give the student a better mental picture of the qualitative scheme and thus point to a clearer understanding of it. The chapter on "Systematic Analysis of Substances" is entirely too brief to be of value, except in an elementary course. Similarly, the appendix is so brief that it could have been omitted without detracting from the value of the book.

G. G. MARVIN.

A Laboratory Manual of Elementary Physical Chemistry. By EDWARD MACK, JR., and WESLEY G. FRANCE. *D. Van Nostrand Company, Inc., New York City. Pages 195+xi. Price $2.00.*

Prepared as a companion volume to Dr. Hugh Taylor's "Elementary Physical Chemistry," this manual has come to serve a double purpose, for while acting as an admirable laboratory guide, at the same time it fills out a few weak spots in Dr. Taylor's own book. The first part of the work as outlined, consists in three exercises. The first is an interesting discussion on units and measurements; the second consists in the construction of a slide rule from logarithmic graph paper — an exercise which beautifully illustrates the theory of logarithms; the third is a short discussion on the errors of measurement and the propagation of errors.

The rest of the volume consists of thirty-five selected experiments and while the selection is a noteworthy one, it is to be wondered whether the equipment of a small college could stand the drain. Starting with the Victor Meyer method of vapor density measurement, we find such classical experiments as the Kundt (as well as the Clement and Desomes) methods for the measurement of Kappa, the measurement of thermal conductivity and vapor pressure of gases, the viscosity of liquids, and the size of molecules in an oil film. The technique of instrument manipulation is covered by an exercise on the polarimeter, spectroscope, and the bomb calorimeter. For the latter part of the course we find experiments on the distribution coefficient, catalysis, the action of light on equilibriums, the measurements of dielectric constants and electrical conductivity, the preparations of a standard concentration cell, the hydrogen electrode, and several experiments on colloids and fine grain solutions.

Each experiment is begun by a short but, in most cases, adequate discussion, after which the experimental directions are given. Numerous questions are scattered throughout the whole and a convenient list of text book references covering the work under discussion is included.

H. A. R.

Handbook of Domestic Oil Heating. Edited by HARRY F. TAPP. *The American Oil Burner Association. Pp. 383, fully diagrammed. Price $3.00.*

It sometimes happens that books written obviously for propaganda of some sort or another actually contain a number of parts of extreme merit along with those which are necessarily for the public's eyes. It is seldom possible to find a book which fulfills the above statement as neatly as does this handbook, and on this basis might be classed with the Carnegie Pocket Companion. Starting out with a chapter devoted entirely to definitions and explanations of terms used throughout, the book ends with a chapter entitled "Miscellaneous Information and Tables," after covering a maze of facts, the breadth of which is seldom seen.

Chapter Two on heat transfer and heating requirements recommends itself immediately, not only to the heat engineer but to the architect and building contractor as well, for a series of extremely convenient coefficients of heat transmission tables is included. This covers practically every conceivable type of wall and roof construction used and is sufficiently elastic so that many sub-types can easily be set up and calculated. Exposure factors and radiation estimates are also included.

The following few chapters are devoted to fuel oil and its characteristics, and includes a discussion of probable geological formation as well as the fuel oil specifications adopted by the Oil Burner Association.

We next find a comparative set of fuel casts, a discussion of various oil burner types, a discussion of the relative merits of storing and pumping devices, and then several chapters on hot water, hot air, and steam heating devices. Inspection installations and tests are next considered, and finally sales and service and the various state and city ordinances are taken into consideration.

Not only oil burner salesmen, but engineers, architects and contractors will find this a convenient source for much information unobtainable elsewhere, except from persons of large experience. It has been written for these men and is highly recommended to them.

H. A. R.

The Electric Word — The Rise of Radio. PAUL SCHUBERT. *The MacMillan Company, New York. Pages 311+vi. Price $2.50.*

For the man who enjoys an historical biography we recommend "The Rise of Radio" without reservations. It is not necessary that the reader should possess a working knowledge of "wireless" or a large vocabulary of words of an electrical significance. In fact, the book is obviously written to attract the layman as well as the engineer who desires a little more than the necessary mathematical deductions.

The book starts with Marconi's early successes and failures in his "wireless telegraphy" experiments and causes the reader to feel in somewhat the same way as did his early contemporaries — that he was not a great scientist but a scientific business man. In spite of this we are led to marvel at the man's sense of practicality and to realize that his great work was not in discovering something new but in putting together in a workable manner the single discoveries and inventions of others.

In the first part of the book we follow the progress of radio from Marconi's earliest experiments in 1896. We see his smaller and larger successes. We watch the envious eyes of neighboring European countries and smile at their attempts to copy. We laugh outright at the thousand tiny squabbles and the peculiar arrangements used so no one but the properly appointed officials of the Marconi companies could receive messages. We finally applaud when we read about the first trans-atlantic tests in 1901. The radio was by this time a maritime necessity.

In the second part of the volume the

(Continued on page 316)

Ransome Standard Building Mixer & Monkey on a Stick

A Ransome 14-S Standard Building Mixer and Monkey-on-a-stick operating on a job for the Port Reading Railroad at Bound Brook, N. J. H. Denberger Contracting Company, Bethlehem, Pa.

Simplicity

Here's a Ransome "three bagger" (1-2½-4) that is noted for its *simplicity* in construction.

The parts of the old model Ransome 14-S were very accessible and easy to replace—but this new model surpasses it.

A Ransome Monkey-on-a-stick and a Ransome 14-S make a combination capable of a large daily output and delivery of concrete.

And this equipment will make *money* and *speed* on *your* job.

Write for the bulletin "A Three Bagger" and Monkey-on-a-stick pamphlet.

RANSOME DOMESTIC REPRESENTATIVES

ALBANY, N. Y
Sager-Spuck Supply Co., Inc.
ASHEVILLE, N. C.
Sutton-Osborne Supply Co.
ASTATULA, FLA.
Prescott Machinery Co
ATLANTA, GA.
Williams-Small M'chy Co.
B. F. Avery
BALTIMORE, MD
Giles & Ransome
BIRMINGHAM, ALA.
Smith-Meadow Supply Co.
BOSTON, MASS.
Clark-Wilcox Co.
BUFFALO, N. Y.
The Wheeler-Murray Co.
BUTTE, MONTANA
Western Supply Co.
CLARKSBURG, W. VA.
Clarksburg Supply & Equipment Co.
CHARLOTTE, N. C
W. Fred Casey and Co.
CHATTANOOGA, TENN
Brown Craven Equipment Co.
CHICAGO, ILL.
Ransome Concrete Machinery Co.
CINCINNATI, OHIO
The C. Taylor Handman Co.
CLEVELAND, OHIO
E. F. Fegg Co.
COLUMBIA, S. C.
Construction Equipment Co
DALLAS, TEXAS
J. W. Barthelow Co
DAVENPORT, IOWA
The Johnson-Beckwith Equipment Co.
DETROIT, MICH
W. H. Anderson Tool & Supply Co.
FORT WORTH, TEXAS
J. W. Barthelow Co.
GRAND RAPIDS, MICH
W. H. Anderson Tool & Supply Co.
HUNTINGTON, W. VA.
Banks-Miller Supply Co.
INDIANAPOLIS, IND
Frank Messenger
LOS ANGELES, CALIF
Emick & Co.
MEMPHIS, TENN.
Pidgeon Thomas Iron Co
MINNEAPOLIS, MINN
Wm. H. Hale & Co
MOBILE, ALA.
Lawrence-Goodling Co., Inc.
MONTREAL, CANADA
Canadian Equipment Co.
NASHVILLE, TENN
R. L. Stockard
NEWARK, N. J
Johnson & Dealaman, Inc
NEW HAVEN, CONN
The W. I. Clark Co.
NEW ORLEANS, LA
Ole K. Olsen
NEW YORK CITY
Fitzgerald & Hudson
NORTHPORT, N. Y
F. G. MacDonald
OAKLAND, CALIF
R. T. McClelland
PHILADELPHIA, PA
Giles & Ransome
PITTSBURGH, PA
Rasme Machinery Co
PORTLAND, ORE.
McCracken-Ripley Co.
RICHMOND HILL
Long Island, N. Y
Fitzgerald & Hudson
RICHMOND, VA
Ed P. Phillips Machinery C
ROCKFORD, ILL
Swords Bros. Co.
SAN ANTONIO, TEXAS
J. W. Barthelow Co
SEATTLE, WASH.
Star Machinery Co.
SPOKANE, WASH.
Hallidie Co.
ST. LOUIS, MO.
Lincoln Equipment & Materials Co.
SYRACUSE, N. Y.
The Wheeler-Murray Co.
TOLEDO, OHIO
National Supply Co.
TORONTO, ONTARIO
Clare Osborn, Ltd.
VANCOUVER, B. C.
B. C. Equipment Co.

RANSOME — AMERICA'S FIRST MIXER

Ransome Concrete Machinery Company

1850—Service for 78 Years—1928

Dunellen New Jersey

Science and Fire Fighting

(*Continued from page 286*)

Any blaze can be successfully put out if it is taken soon enough. All fires are small at the start. Thus the means for calling men and equipment to the scene of a blaze is of the utmost consequence. Modern science has made the reception of an alarm of fire at headquarters a matter of seconds after the box has been pulled. Ingenious electrical and mechanical devices relay the message to the various companies, police, and others concerned. When apparatus has been efficiently placed, water may be poured into a burning building from many lines of hose within a few minutes of the discovery of fire. The placing of alarm boxes to best advantage is a problem which should be carefully considered by any community, and the education of the citizen in the simple procedure required for the sounding of an alarm of fire is a civic duty. Unbelievable losses have resulted from ignorance of the proper methods to employ. Too simple an alarm defeats its purpose, due to the ease with which false alarms can be sounded with but slight risk of detection. The cost of sending apparatus in response is negligible — and in many cities is considered a practice run — compared to the damage resulting from the apparatus being away on such a call when needed for a real fire. Only a few weeks ago, in Boston, there occurred an epidemic of false alarms — some seventeen being sounded in a period of four hours. This in itself is bad; but infinitely worse is the fact that a serious fire was discovered while apparatus was more than a mile away on a false alarm. Fortunately immediate communication was established with fire alarm headquarters by the officer in charge of the apparatus, so that equipment was returned to scene of the blaze at once. Firemen stated that loss of at least three lives would have resulted in all probability if the response had been delayed another five minutes. Conservative estimate places the monetary loss at $8,000 where it should have been very small.

The first fire alarm telegraph system in the world was invented, constructed, and placed in operation in Boston in 1852. The system has been extended and improved until from three box and bell circuits, forty boxes, sixteen alarm bells, and a crude central office equipment exposed to serious fire hazard, it now occupies ideal quarters and is splendidly equipped. No building can ever be erected nearer than 250 feet of the new central office. The building itself is of fire resistive construction, and harmonizes with its surroundings in the park system. It is large enough to care for the city's natural growth and the possible annexation of surrounding communities. More than 1,300 alarm boxes connected to 73 box, 18 tapper, and 16 gong circuits are now in service. Special circuits communicate with the high pressure pumping system. The ultimate capacity is 5,000 boxes.

Each incoming alarm is registered by shearing the signal in a paper tape, and at the same time the exact time of its receipt is stamped on the paper. Three four-dial, four-number transmitters are provided for sending the alarms to the engine houses. Two separate circuits run to each house, one for the loud sounding gongs, and the other for the desk apparatus. Telegraphic communication is possible over all the lines connecting street boxes for test purposes as well as for the transmission of information, orders and special signals. Boston has at its headquarters registers which shear the incoming telegraphic signals into a paper tape as a permanent record. Some 6,500 storage battery cells, arranged in two sets, furnish current for the system. One set is being charged while the other is in operation. Elaborate test boards are provided to check up on the system and the batteries. In addition, two sources of outside current are available and there is provided for emergency use a gasoline driven generator so that unfailing current is practically a certainty. The dispatchers can keep a check on the location and movements of apparatus on a large map. A radio serves to check the time mechanism with the official Arlington time signals, as well as to act as a broadcasting station for fire use in communicating with the fire boats, for example.

Research is constantly in progress to investigate fire hazards developed by the forward march of science. The airplane,* the blimp, and the rigid dirigible have brought their own peculiar problems. Crash fires are being studied on actual planes by direct observation, motion pictures, and special camera records. The design of fuselage and motor, of ignition systems, gasoline storage, exhaust systems, etc., has been altered and modified to reduce or, as far as possible, to eliminate the ever present danger of fire and explosion.

The quantities of pyroxalin films in storage, use, and transit present a serious problem.† Disastrous fires of recent origin in X-ray film storage vaults of hospitals have shown that much is yet to be learned of the behavior of such materials under what had always been supposed to be safe conditions.

That modern methods are successful is shown by the reduction of the fire loss per capita in cities where greater efficiency has been developed in the fire-fighting personnel and in the equipment with which they work. The per capita fire loss of Boston was reduced from $8.18 in 1923 to $4.92 in 1927. William H. Winkley, manager of the Boston Board of Fire Underwriters, commented on the reduction as follows:

"This was not because of any material reduction in the number of fires, but because of a marked decrease in the number and amount of large individual losses. . . . Constructive changes made by the Fire Commissioner, such as more effective 'running card' and better disposition of apparatus, and immediate massing of men and equipment by quickly sending in second or third alarms when response to the first alarm reveals conditions that might result in a bad fire, had a very positive and important part in producing this result."

The appalling size of the fire loss for the country ($478,245,620) indicates that the end is not yet, and that science must continue to study the records of the past and to push forward as new avenues are opened. The modern engineer has opportunities undreamed of in the past. He now burns down whole buildings for the purpose of studying what happens to different types of construction and furnishings under various occupational loadings and exposure hazards.* He has at his command the combined resources of engineering, chemistry, electricity, and physics.

Modern methods of rapid transit and communication make it possible for the fire protection engineer to learn details of fires and in many cases to reach the scene of the blaze in time for first-hand observation. The study of reports thus made, plus the statements of the fire department officials in charge, make evident any abuses of privilege.

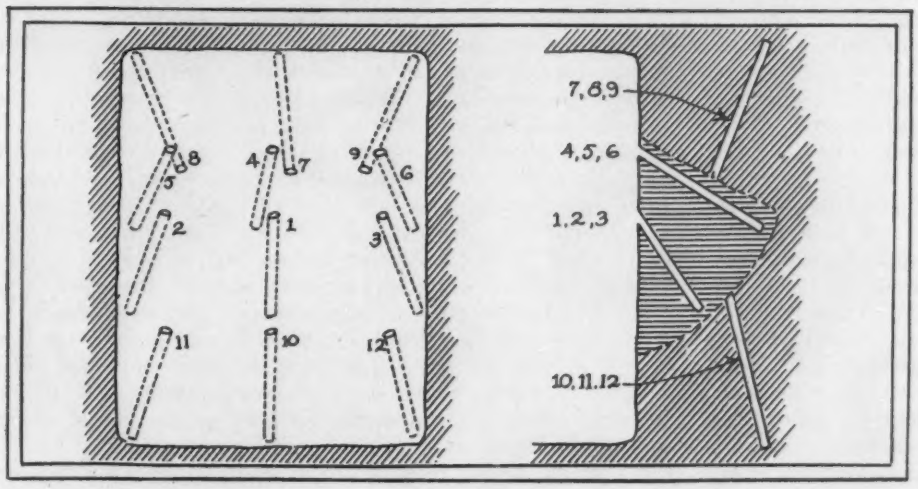
The coördination and dissemination of the data already available and the intelligent direction of further research form a legitimate and important field for the technically trained man.

*See National Fire Protection Association *Quarterly*, October, 1928. "Aviation Fire Hazards."

†See "Fire Protection of Pyroxalin Plastic," Inspection Department *Bulletin*, Associated Factory Mutual Fire Insurance Companies (November, 1928).

*See articles by S. H. Ingberg of Bureau of Standards. "Tests of Severity of Building Fires," "Fire Test of Brick Joisted Buildings." National Fire Protection Association *Quarterly*, July, 1928.

Choice of Explosives for Ore Mining



LESSON NUMBER TWELVE

BLASTERS' HANDBOOK

IN ore mining, the selection and use of explosives becomes nothing less than a fine art. Every formation of ore and rock requires a different explosive. Drilling and loading methods must be correctly performed to ensure satisfactory results.

For instance, what explosive would you use where moisture is present in excessive quantities, which explosive to produce the least obnoxious fumes, which dynamite to use below or above ground, which kind for soft or for hard rock? How can you choose explosives to reduce the hazard of igniting gas and dust mixtures?

Some day you'll need this information

You may need to know the answer immediately. Textbooks—even the best—do not contain this vitally important data. During the last 125 years du Pont has been making and testing explosives for every type of blasting operations. These tests have been applied to all industries where explosives were essential.

This coupon will bring you a copy of the Blasters' Handbook without any cost. It's a reference book for explosives' users. Some of the largest engineering colleges use the Blasters' Handbook in their engineering classes. You need it today and you'll need it even more when you're out in the field.

Mail the coupon for your copy NOW

DU PONT
REG. U.S. PAT. OFF.

E. I. DU PONT DE NEMOURS & CO., INC.
Explosives Department, Wilmington, Del. TE-12

Gentlemen: Please send me a copy of your Blasters' Handbook.

Name.....

Address.....

The Industrial Application of Microbiology

(*Continued from page 291*)

a yield of glycerin which is profitable it is necessary to acclimatize the organism to grow in sugar solutions rendered alkaline by use of sodium salts, a condition quite different from that encountered in industrial alcohol production where an acid medium is necessary. The yeast, growing in sugar solutions thus alkalinized, produced both ethyl alcohol and glycerin and the fermented solution must then be subjected to direct distillation for the alcohol and a special steam distillation to secure the glycerin. Undoubtedly the near future will see much glycerin produced in this way.

Lactic acid is not of great importance commercially, but is used to some extent in many industries, notably in tanning. It may easily be produced by the fermentation of skimmed milk by lactic acid bacteria, but commercially is made from various grains and other carbohydrate material. Considerable work has been done on the utilization of corncobs as a source of this acid. Several bacteria have been studied which will produce equal quantities of this and acetic acid by fermentation, and the use of this waste product for such a purpose may eventually prove practical.

Citric acid is mostly obtained from lemons by chemical means. It has long been known, however, that certain molds will produce this acid in special media, and there is at least one plant in this country today which produces citric acid commercially by the use of molds.

The production of yeast for bread making and for human consumption as a source of vitamin B has greatly increased in the last few years. Formerly yeast was a by-product of the fermentation industry, but now it has become a major product. To produce yeast in large quantities economically, an understanding of its physiology must be had. When yeast grows in a nutrient solution containing sugars, and when very little air is present as in industrial fermentations, reproduction takes place to some extent but the greater part of the energy is used in converting the sugar to alcohol. However, if the same solution is aerated, alcohol production is very slight, while the yeast cells reproduce themselves in enormous numbers. Thus a large amount of yeast is quickly produced. This underlies the modern "aeration method" of yeast manufacture, where as high as forty per cent of the material used in the nutrient solution is converted into yeast cells. The process must be carefully controlled — the nutrient solution prepared according to the physiological needs in yeast cell reproduction, the culture kept at the right temperature, the period of growth kept constant, and above all, the prevention of contamination by extraneous microörganisms. The yeast is then separated from its nutrient solution and pressed into cakes, the compressed yeast of commerce consisting of practically nothing but yeast cells.

The production of acetic acid and vinegar by microörganisms is well known and the theory of vinegar making will illustrate both. When cider or malt is used, the sugar must first be changed to alcohol by yeast fermentation. Then the alcohol is oxidized to acetic acid through the action of several types of "vinegar bacteria." In the commercial "quick vinegar process," a dilute alcoholic-nutrient solution is allowed to trickle over a large surface of shavings which have been soaked with a culture of the acetic acid or vinegar bacteria, while air is forced through. Since a large surface is presented, oxidation takes place rapidly, and about four per cent of acetic acid is produced. Many acetic acid bacteria are known which will produce good quantities of acetic acid from various materials, some of them from sugar directly.

The importance of various microorganisms in the manufacture of food products such as bread, butter and cheese is common knowledge. The bacteriology of sauerkraut-making is not as well known perhaps. In making this food, salt is first mixed with the cabbage in a suitable container and pressure applied. The salt serves to help draw the juice from the leaves, and also to keep extraneous organisms from growing. This juice contains sugars which are then changed to lactic acid by the lactic acid bacteria occurring naturally on the cabbage leaves. Silage, which is such an important cattle food, also results from a slight lactic acid fermentation of cornstalks and leaves and other plant products.

Japanese soy-bean sauce is the result of the enzymatic action of a mold, and to a lesser extent, yeasts and bacteria, on soy-bean brine mash. The process takes several months, and many complicated reactions take place.

Fermented milks are found in many countries. Some are produced by the action of bacteria and some by yeasts. In this country, the commercial fermented milks are the result of the action of lactic acid bacteria, B. acidophilus and B. bulgaricus. It has been claimed that fermented milks have therapeutic value, but this is not definitely established.

Space forbids further description of the processes listed in the first class. They are representative of the possibilities that await the bacteriologist with imagination and power of observation. It is entirely probable that the future will see the utilization of bacteria and other microörganisms in production of many kinds of chemical reagents and technically desirable products.

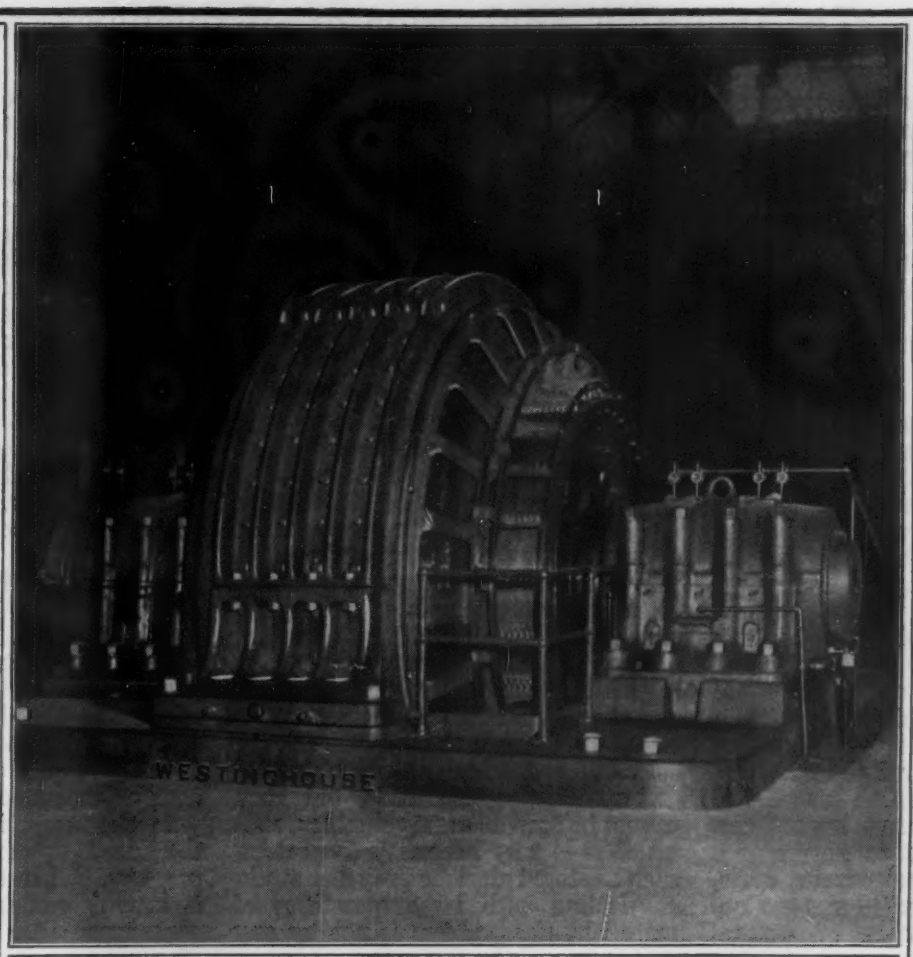
Among the preventive processes the great food preserving industry stands in first place, but many others now relatively insignificant are sure to forge ahead and become of real significance. Food preservation by cooking and drying are as old as civilization, and the use of salt in curing meats and fish and of sugar for preserving fruits are also ancient processes. The preparation of dried salt fish was the first American food industry on a commercial scale. Refrigeration came into being as a process of what may be called world importance less than sixty years ago. The giant among the food preserving industries is what we know today as canning. This had its inception in England and France soon after 1800. A patent on a process for preserving foods by hermetically sealing in jars and exposing to the action of heat was granted to Appert in France in 1809, about fifty years previous to the work of Pasteur, which is sometimes assumed to be the foundation of all our industrial work in this field. By 1820 William Underwood had brought the Appert process to Boston and established here the house that still bears his name. This was the beginning of canning in America. Expansion was limited until the Civil War gave impetus to the business. New methods of treatment were introduced, and the term "processing" was the one commonly employed to indicate the heat treatment. The exact nature of this treatment was not generally understood until it had been carefully worked out at M. I. T. in the late nineties, and before then losses from spoilage were sometimes enormous. This field of industrial microbiology, for such the canning industry really is, has had phenomenal development and is destined to further expansion. Its underlying principle is extremely simple to the bacteriologist, for it is based on the knowledge of the temperature relations of bacteria and their spores. Incidentally, while simple in theory, there is a vast field for detailed study and many collateral matters to take into consideration. One of the most interesting aspects of these questions today relates to the behavior of the so-called heat-loving bacteria, organisms that

(*Continued on page 304*)

J. J. MELLON,
General Engineer,
Rensselaer, '24

J.M.CUNNINGHAM,
Power Engineer,
Colorado School of Mines, '22

J. F. KOVALSKY,
Contract Administration
W. T. N. S., '24



YOUNGER COLLEGE MEN
ON RECENT WESTINGHOUSE JOBS

W. G. COOK,
Control Engineer
University of Pennsylvania, '25

A. F. KENYON,
General Engineer
Iowa State College, '22

CLARENCE LYNN,
Designing Engineer,
University of Kansas, '19

The Largest Hot Strip Mill in the World

Where do young college men get in a large industrial organization? Have they opportunity to exercise creative talent? Is individual work recognized?

* * *

SQUEEZED between giant rolls, heated steel bars flatten to form steel sheets for the bodies of the automobiles that modern America demands.

So rapidly has this demand grown within the past few years that the American Rolling Mill Company, of Middletown, Ohio, recently found it necessary to install a "hot strip" mill larger than any before.

Such record-breaking capacity brought with it a train of new problems. Electric control had to be devised to keep the big 3,000 and 4,000 hp. D. C. motors "in step" and prevent irregularities in thickness or quality of the finished sheets. Huge generators and transformers had to be designed to handle the power requirements of this new mill — the largest of its kind.

* * *

To Westinghouse came the assignment of designing, manufacturing, and installing this equipment. Opportunities of this caliber are not rare in an organization with the resources which Westinghouse commands. Westinghouse attracts young men of enterprise and genius because it daily provides opportunities which smaller companies can seldom offer.

Westinghouse

The Industrial Application of Microbiology

(*Continued from page 302*)

defy the common laws of protoplasmic bodies and thrive at temperatures which are fatal to ordinary bacteria, and above the coagulating temperature of many proteins.

The great range of food products which may be so treated—meats, fish, shellfish, soups, vegetables, fruits, milk, etc., bring an equally great variety of specific problems which the manufacturer must solve if he would insure himself against loss.

Closely allied to the canning industry is another dealing with food specialties of all kinds — pickles, salad dressing, catsup, sauces, jams, marmalades and the products such as peanut butter, oils, etc., in all of which the bacteriological problem may be the most important one.

The relation of molds and bacteria to the destruction or deterioration of wood and cordage is another large field of preventive microbiology. With a diminishing lumber supply the conservation of timbers, railway ties, telegraph poles and building material is bound to assume increased importance. The rotting of wood in nature is a natural biological process or cycle, without which life could not go on, but when deterioration of natural products which we are using occurs, it is of more immediate economic importance. Hence methods of prevention must be worked out, based on the biology of wood decay and the physiology of microörganisms concerned.

A very large number of molds, especially, cause rotting or discoloration of various woods. Since molds are much more complicated than yeasts or bacteria, the problem of their control is also harder. Then, too, the fact that many wood products must be exposed to the elements is another consideration. If we impregnate the wood with preservatives, the question of solubility must be considered. Likewise, we must often consider the question of the color, odor and cost of the preservative. The most common methods of wood preservation include painting, charring, dipping in tar or creosote, impregnating with tar or creosote under pressure, and the use of zinc chloride and other salts. In general, these work well for such things as railway ties and underground building materials, but they cannot be used on some valuable woods which it is very necessary to protect, such as stored airplane propeller stock. In dealing with large quantities of materials, the problem is not by any means a simple one. For example, trouble has occurred in stored wood pulp destined to be made into paper. The whole problem needs more biological study.

In the field of textiles, losses due to the deterioration of cotton, both in the fiber and in the woven condition, of linen, hemp, jute and other cordage fibers, are sufficiently great to warrant careful study from the standpoint of the industrial microbiologist, and this field is sure to receive far more attention in the future than it has in the past. We are all familiar with the rotting of such things as canvas tents which are exposed to the elements, and in the tropics deterioration of cloth of all kinds is of importance. Deterioration of cotton yarn and cloth particularly, often occurs in the manufacturing process, due usually to mold action. The result may be discoloration, weakening or even partial destruction. The practice of using starch sizing materials on the cotton yarn is an undesirable one biologically, since it furnishes food material on which microörganisms can thrive. Many different chemical substances may be used during the processing and on finished cloth to prevent or retard mold action, but conditions vary so much, and so little real study has been put on the problem, that a satisfactory solution is not yet at hand. Even wool is not exempt from troubles of this character, but here the damage from moths which may attack the fiber or the cloth is far greater, and has stimulated the development of processes of mothproofing. This, however, is in the field of economic entomology rather than industrial microbiology.

In the manufacture of cane sugar, the juice is extracted from the cane by pressure, and in this natural condition is heavily contaminated with microorganisms. Due to the warm climate of sugar-cane countries, fermentation may start as soon as the juice is separated from the cane. To overcome this, one of the fundamental principles of microbic physiology is applied, namely, concentration of the nutrient medium surrounding the microörganism to a point where growth cannot take place. Even then, trouble is sometimes experienced, because there are a few yeasts which can grow naturally in very concentrated sugar solutions, or they may become "acclimatized" to the high concentration. This is only one of the biological problems of sugar

(*Continued on page 306*)

Burn Jeddo-Highland

Aristocrat of Anthracite

MORE Even Heat Comfort Healthful LESS Ash Smoke Care

An analysis of Jeddo-Highland Coal made recently by O. K. Bates at the Massachusetts Institute of Technology shows the following:

B.T.U. per pound of dry coal 13,970
Ash..... 5.3%

Jeddo-Highland stands preëminent among the anthracite coals, both foreign and domestic, for its low ash and high heat content, entire absence of clinkers, and ability to hold a good even fire for many hours without attention.

Sold exclusively in Boston and Suburbs by

THE STETSON COAL COMPANY

Telephone, South Boston 0382 or 0113

GIFTS

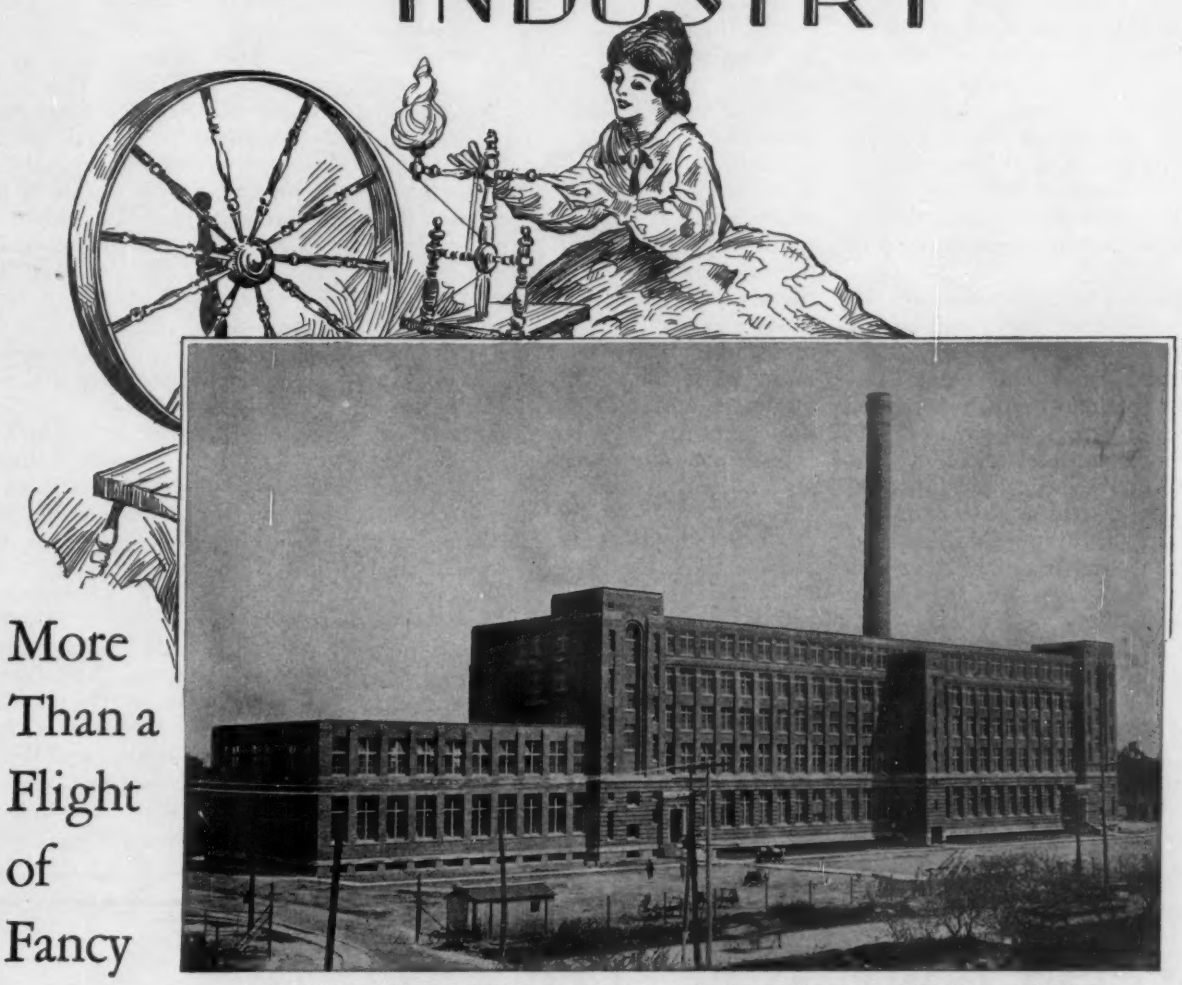
Fine tools are priceless gifts. The man who uses drawing tools will prize one made by *Alteneder.*

Send for Gift Circular

THEO. ALTENEDER & SONS

1226 Spring Garden Street, Philadelphia

INDUSTRY



More Than a Flight of Fancy

COURTAULDS, LIMITED, CORNWALL, CANADA. CONSTRUCTED BY THE FOUNDATION COMPANY

PREHISTORIC man clothed himself in the skins of the animals he killed for food. Later he used the hair alone, woven into a covering for his body, varying this with fabrics made from plants, as cotton and linen, for warmer climates and seasons.

In the far east the natives took the filament from the cocoon of the silk worm and spun and wove it into a soft and beautiful textile, much desired in Europe and America since its introduction by early seafarers.

Chemists have now produced artificially a fibre similar to the silkworm's and fabrics woven from it are produced in great quantities under the name of Rayon.

The Foundation Company has constructed a number of factories both at home and abroad, for the manufacture of Rayon.

THE FOUNDATION COMPANY

CITY OF NEW YORK

Office Buildings · Industrial Plants · Warehouses · Railroads and Terminals · Foundations
Underpinning · Filtration and Sewage Plants · Hydro-Electric Developments · Power Houses
Highways · River and Harbor Developments · Bridges and Bridge Piers · Mine Shafts and Tunnels

ATLANTA
CHICAGO
PITTSBURGH
SAN FRANCISCO

MONTREAL
LIMA, PERU
CARTAGENA, COLOMBIA
MEXICO CITY

LONDON, ENGLAND
PARIS, FRANCE
BRUSSELS, BELGIUM
TOKYO, JAPAN

BUILDERS OF SUPERSTRUCTURES AS WELL AS SUBSTRUCTURES

The Industrial Application of Microbiology

(*Continued from page 304*)

manufacture. Another important problem is the deterioration of sugar in storage. Due to the action of bacteria present, acids and enzymes may be produced, and the sugar may be inverted to a greater or lesser extent. The first problem is of less importance in the manufacture of beet sugar, because of the cooler climate, but deterioration in storage may occur in any sugar.

The control of microörganisms in the manufacture of fruit juices and beverages is too well known to require exposition. We know that these substances are excellent culture media for the growth of microörganisms, and further, we must consider the fact that yeasts, especially, occur naturally on large numbers of fruits. Pasteurization or sterilization is often used to prevent fermentation, but in such things as peach juice, the flavor is destroyed even by pasteurization. Chemical preservatives are perhaps used to a greater extent than any other method of preservation.

Since in a large number of cases, the ultimate solution to the control of microörganisms is through disinfectants and fungicides, the subject has received much attention. Because the physiology of the microörganisms concerned has been so little understood until quite recently, much of the work on this problem has been of the trial and error method, rather than of scientific nature. We know how important disinfection is in medicine, and in industrial microbiology it is equally important. We have wood preservatives, antiseptic substances for cloth, preservatives for foods and so on. Then there is the problem in agriculture — fungicides to prevent destruction of crops and of trees. Much work remains to be done in this field, after the physiology of the microörganisms is better known. In plants, the problem is more complicated than when dealing with animals, and the microbiologist in this field has unlimited opportunity.

An article of this scope can touch only certain aspects of the subject, and these but superficially. It is, of course, obvious to the reader that to go deeply into all phases of bacteriology in industry, or even to touch upon all the branches of industry listed in an earlier paragraph, would have too much the character of a textbook rather than an article designed primarily to promote the broad interests of the scientific or engineering student.

Departmental Notes

(*Continued from page 296*)

equipotential electrical lines. The preceding summer he was in Oklahoma and Texas, using gravity and magnetic methods. This subject has become of so much importance that the Regional Meeting of the American Institute of Mining and Metallurgical Engineers, which was held in Boston the latter part of August, was devoted entirely to papers and discussion of it alone. This was the first time that the American Institute of Mining and Metallurgical Engineers had met in Boston for about forty years.

The annual meeting of the Advisory Committee to the Department was held in President Stratton's office on October 19. It was followed by a luncheon at his house. In addition to specialists from nearby, there were present Ralph Sweetser from Columbus, Ohio; William M. Corse from Washington, D. C.; Lawrence Addicks from New York; H. A. De Fries from Watervliet, New York: Samuel Hoyt from Schenectady, New York; B. D. Saklatwalla from Bridgeville. Pennsylvania; E. D. Martin from East Orange, New Jersey; and W. R. Ingalls and Van Rensselaer Lansingh from New York City. The result of this

(*Continued on page 308*)

RECENT CONTRACTS
Executed by
Jeremiah Sullivan's Sons

Improvement of Great Court
Excavation for
Aeronautics Laboratory
New Dormitories
Engine Laboratory
Homberg Memorial Infirmary

Jeremiah Sullivan's Sons
25 WILLARD STREET
CAMBRIDGE
Telephone, University 3632

Mr.
Technical
Advertiser

Your advertisement in

The Tech
Engineering News

Would put your name before the "to be greats" among the engineers of the future.

WHEN your college course is completed and your business career begins, if your responsibility concerns the transmission of power through moving parts—then you will be brought face to face with friction and its Siamese twin—Waste.

Learn now, and remember then, how to ward off Waste, how to replace friction with anti-friction, how to apply Timken Bearings wherever wheels and shafts turn.

The conquest of friction is only part of the story. For Timken Bearings are more than anti-friction, providing full radial-thrust capacity, greater bearing surfaces and space saving compactness.

—And as a climax—the exclusive combination that safeguards against wear—Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken electric steel.

Whenever it becomes your problem to ward off Waste you can solve it easily by using "Timken-Equipped" as a guide to guard against loss.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**

Departmental Notes

(*Continued from page 306*)

meeting was an exchange of ideas which should be helpful both to the Committee and to the members of the staff.

Graduate students are doing interesting work in the Department. Mr. K. Murikami, who is superintendent of a Japanese ore concentrating mill using froth flotation, is spending a year at Technology making a special study of flotation. Prof. John L. Bray of Purdue University spent the summer in the laboratory and made a beginning on his study of the causes and prevention of corrosion of iron and steel, looking toward the possible application of better protective coatings than are in use at present. Mr. L. B. Barker is working on the cause and prevention of gases in bronzes. Mr. J. P. Walsted is carrying out an elaborate series of tests on the method of hardening the surface of steel by the nitriding process, including the properties of the nitriding material and a study of the many and constantly increasing uses of this form of surface hardened steel. This is a line of work which Dr. Homerberg of the staff has been working on extensively for some time and he is, consequently, following Mr. Walsted's work very closely.

CHARLES E. LOCKE.

Industrial Possibilities of X-Ray Examination

(*Continued from page 289*)

failure reflects considerably upon the reputation of the maker and he must be certain that the castings which he ships out are sound; not some others which are just like the ones to be used and which he has tested, but the particular ones which are to go in service. Examples of castings of this class are the fittings for high temperature and high pressure steam and oil equipment. Consider it from the point of view of expense. To replace a defective fitting in such service means a large expense both for the actual operation and for the tie up of equipment, an expense many times that of a complete X-ray examination. The expense of machining large castings is considerable and if the finishing cut opens up a serious shrinkage cavity or other defect, this expense goes for naught. Structures which contain important welded joints also come into the class which can profitably be examined by means of radiography. Here again it is the special job that needs X-ray examination and not the routine class of work. But in many fields of application, welding may still be considered as yet in an experimental stage so that the need of a thorough examination is greater than in the case of more thoroughly understood processes.

There are two general methods of carrying out this radiographic work. One is to bring the castings to the X-ray laboratory where the complete equipment is available and where the examination can be made as complete as is necessary. The disadvantage of this method is the expense of shipping the castings, which frequently are very heavy, from the foundry to the laboratory. The other method is to transport the X-ray equipment to the place where the castings are made. There is not at present any really portable X-ray equipment of the capacity needed for large castings, but it has been suggested that the equipment be mounted on a motor truck which could be driven to the particular foundry or manufacturing plant. This scheme is perfectly feasible and has much to recommend it, particularly if many castings are to be examined.

The expense of taking radiographs is of course an important item. It has been estimated that if a comparatively large number of castings are to be examined, the cost is in the neighborhood of five dollars for each picture. It might vary from half this amount to twice depending upon the complications of the object and the time re-

(*Continued on page 310*)

Mineral Prospecting---

Science Replaces Guess-work

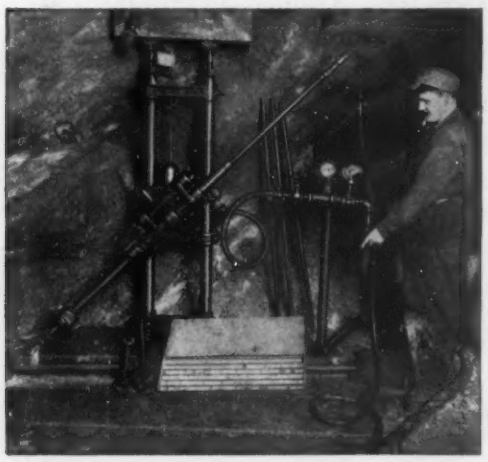
The old time prospector, once a familiar figure in the West, is seldom seen today. Modern engineering has developed a more accurate and economical method of finding ore, coal, and oil—the diamond core drill.

Boring downward, or upward, or horizontally, Sullivan Diamond Drills take cores which are actual samples of all the strata penetrated. They tell the depth of the mineral sought, its extent, inclination, and by assay, its value.

In addition to helping develop natural resources, these drills insure the safety of bridges, dams, and buildings—by definitely locating the bed rock to support them. *A booklet describing Sullivan Diamond Drills will be sent free on request.*

The old time prospector, grub-staked and off for the hills

A Diamond Drill Core, taken from oil strata



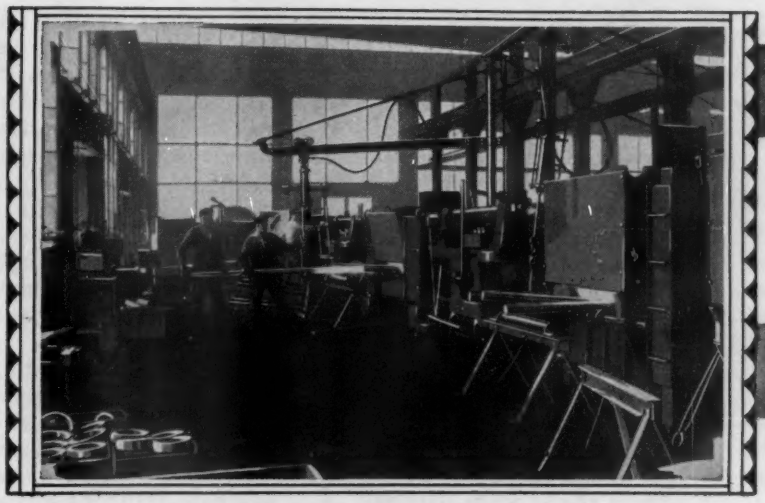
The Modern Prospector, a Sullivan Diamond Drill in a Copper Mine

An Opportunity for You

The Sullivan Machinery Company is managed and staffed by engineering graduates of colleges like yours. And each year a few new men are selected. *Send for the booklet Engineering Sales Opportunities.*

SULLIVAN MACHINERY COMPANY
164 S. Michigan Avenue, Chicago

SULLIVAN



A corner of New Departure's mammoth Forge Plant — one of the largest in the world — where a unique upset forging process gives peculiar endurance to the finished ball bearing.

First form

Second form

Completed forging

Forging the Sinews of Endurance

UPSET forging plays an interesting and important part in making the New Departure Ball Bearing so enduring that it will outlive the machine in which it is installed—*and yet never wear within itself to the extent of requiring adjustment.*

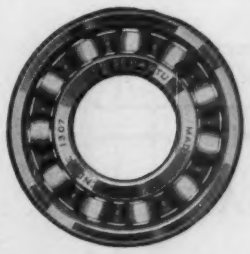
This method increases the density of the steel by compression and likewise controls the flow of the steel fibre —a feature with a direct bearing on endurance life, as will be explained.

The bar is first heated to an exact temperature checked constantly by optical pyrometers to obtain a non-oxidizing atmosphere for the prevention of scaling.

The first blow of the forming die in making the inner race ring produces the shape shown in the first form. This is immediately followed by the second operation, by which the ring is formed. The third or piercing operation cuts the ring from the bar.

Thus the fibre or grain of the steel flows into carefully predetermined channels, bringing it *parallel* to the surface at the points of greatest load in the finished and revolving bearing.

Normalizing and annealing operations which follow relieve all internal strains and greatly refine the grain size of the steel. The direction of the fibre for maximum endurance remains unchanged.



New Departure Ball Bearings

The New Departure Manufacturing Co.
Bristol, Connecticut
Chicago · Detroit · San Francisco

1106

Industrial Possibilities of X-Ray Examination

(*Continued from page 308*)

quired in setting it up. Of this expense, about three-fourths is chargeable to the operator's time and the other fourth to such items as power, photographic materials, depreciation of equipment and overhead. A typical casting may require about ten to fifteen pictures for a complete examination. A cost of seventy-five dollars for the examination of a casting seems like a large item compared with the machining cost, for instance, but when one compares it with the cost of replacement of that casting as a unit in a large system, then the cost of the examination is quite small. These figures on the cost of X-ray examination are based on the result of work which has been carried on for several years in the X-ray laboratory of the Department of Physics of the Massachusetts Institute of Technology.

The present state of the situation may be briefly summed up as follows: The X-ray diffraction methods which are of such invaluable assistance to the metallographer are not capable of being applied by the engineer directly to industrial problems. They are laboratory methods which should be applied and interpreted by those particularly trained in this class of work. The results, however, have much to do with the suitability of the material with which the engineer has to work. The radiographic methods are more nearly practical, but here again complication and expense prohibit their application in a routine manner. However, they may be and are being applied successfully to many special problems. There is a great deal of development work still to be done in this field. We are in need of more powerful equipment and more sensitive detecting devices so that the long exposures may be reduced. In radiography we need a method of rapidly examining large areas and only making a careful record of those areas which appear doubtful. This would materially reduce the expense. In the writer's opinion, these developments will take place. The science is quite new and has made remarkable strides in the last few years. It is sufficiently important to warrant this development because it yields fundamental information which in many cases can be obtained in no other way.

Technical Training—Plus

(*Continued from page 287*)

At another time was I compelled to sprinkle sand over the metal roof of a closed car body to show that this roof was vibrating and causing a very disagreeable, unbearable rumble to the passengers in the car. It had been my contention that a soft non-vibrant fabric roof should have been used, for I knew that the entire metal body was an efficient resonator, but I had to prove this and I remembered that old experiment in physics where we sprinkled sand on a plate of glass and then vibrated the plate by rubbing a violin bow over the edge, whereupon, the sand particles rearranged themselves into interesting geometric designs. Precisely this same thing occurred on the metal roof of that automobile.

On still another occasion, upon investigating a disagreeable vibration, we suspected that the body bolts, fastening the car body to the frame, were in the wrong location. You know, of course, that each part, or member, of a structure has its own still period of vibration, just as a violin string or a tuning fork. Now the side bar of a car frame vibrates in the same fashion and there are joints along its length known as nodes and anti-nodes and by placing beakers of gasoline down its length, we could readily pick out these joints. We found that our bolts happened to be located at the very worst joints, namely the anti-nodes, the points of maximum vibration. Incidentally in the experiment it was interesting to note that a very thin liquid, such as gasoline, was very easily disturbed by the vibration as its surface was violently agitated and drops of the liquid actually jumped out of the beaker, whereas, a comparatively heavy liquid, such as water, was scarcely disturbed.

I well recall that in the early production of a now famous motor, we encountered excessive vibration, causing a very aggravating rumble in a closed car body. After a long engineering conference, it was decided that we should make up new experimental parts, involving practically every moving part of the engine. The idea being that in reconstructing and trying out each individual assembly we would stumble across the offending member, which was causing most of our vibration. This procedure was based on what we know as the "cut and try" method, very frequently used by engineers, but not considered at times to be scientific. After leaving the conference and thinking this matter over, I decided that a program as comprehensive as this would entail a delay of at least one month, and, as we were extremely anxious to remedy the difficulty as promptly as possible, I decided that something must be done to short-cut this procedure. This was accomplished in the following manner and we obtained our answer within twenty four hours:

The car with the rough motor was towed behind a second car and the clutch was dropped in with the engine in high gear. It was noted that the

(*Continued on page 312*)

STANDARD
INSTRUMENTS
OF PRECISION

C. L. Berger & Sons, Inc.
Established 1871
37 Williams St., Boston 19, Mass.

STARKWEATHER & BROADHURST
INCORPORATED

Engineers and Contractors for Power Plant Apparatus

79 Milk Street BOSTON Telephone, HANcock 4530

BAILEY METERS

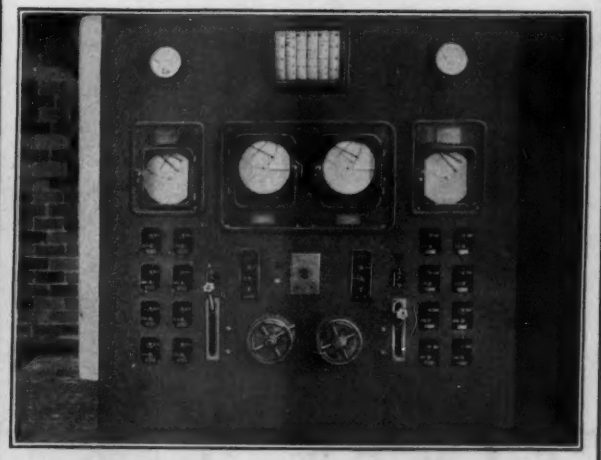
Serving Public Utilities

THE leading public service companies and industrial steam generating plants throughout the country use Bailey Meters because they are essential to the well-organized plant—the plant that accounts for its heat units as carefully as for its dollars.

The high standards of efficiency that prevail in these modern power stations reflect the profitable operating economy assured by Bailey Meter Control.

Bailey Meters keep complete account of all important operating conditions. By their use, you can determine the fuel and stack losses, as well as check the fuel, steam and water consumption. These meters enable the operators to locate and determine the magnitude of the losses so they may be reduced to a minimum and the final results thereby improved. Bulletin No. 81B entitled, "The Heat Balance in Steam Power Plants" will show you how this can be done. Write for a free copy.

Bailey Meter Co.
Cleveland, Ohio



Bailey Meters on a Pulverized Coal Fired Boiler

OKONITE

SINCE 1878
The
STANDARD BY WHICH QUALITY IS JUDGED
in all forms of
RUBBER INSULATED WIRE AND CABLE
VARNISHED CAMBRIC WIRE AND CABLE
IMPREGNATED PAPER CABLE
AND TAPES
Manufactured by
THE
Okonite Company
The Okonite-Callender Cable Co., Inc.
501 FIFTH AVENUE, NEW YORK, - N.Y.

DUDLO

World's Largest Manufacturers of Fine
MAGNET WIRE *and* WINDINGS
For Every Electrical Purpose

Ask for a copy of the DUDLO folder "Wire and Winding Data." It will help you in your work

DUDLO MANUFACTURING COMPANY
FORT WAYNE, INDIANA
Division of The General Cable Corp.

Technical Training—Plus

(*Continued from page 310*)

same vibration was recorded in the car being towed, as was noted when it was running at the same speed under its own power. We then removed successively each moving part, feeling certain that when the offending member was removed, our vibration would finally disappear. Our engine was stripped down until only the crank shaft, connecting rods and pistons remained and the vibration was still there. The pistons, which at that time were made of cast iron and weighed thirty-two ounces, were cut down until they weighed but twelve and one-half ounces. This was done by cutting off the heads to simulate the weight of the aluminum piston. After this experiment our vibration had disappeared.

I mention this because an engineer is compelled at times to use his wits to save work and obtain an answer quickly. Our problems are always intensely interesting.

On still another occasion, I was returning from Bay City to Detroit, late in the evening, when my motor suddenly overheated and the water boiled out of the radiator, one hundred and twenty-two miles from home. I quickly diagnosed the trouble as no water circulation and guessed that the pin, which attached the pump impeller to the pump shaft had been sheared. I afterward found this to be the case. The problem was to get back to Detroit without refilling the radiator every few miles. I remembered that phenomenal gasoline economy can be obtained in a motor after the car is brought up to top speed and the ignition turned off, clutch thrown out and the car allowed to coast down to about ten miles per hour. I reasoned that if phenomenal economy could be obtained in this way, it followed that there would be very little heat lost to absorb in the water. I tried this out, accelerating to sixty miles per hour, then coasting down to ten miles per hour and arrived in Detroit with my radiator full, averaging thirty-five miles per hour for the run of one hundred and twenty-two miles. The gasoline economy was nearly thirty miles per gallon, which was ordinarily about seventeen to eighteen miles per gallon.

In college you are trained to think. Later you must train yourself to decide a good many weighty problems. I have met many men who are brilliantly educated, but who have made miserable executives, due, I think, principally to the fact that they have had a very mediocre business training, and an engineer who has no business training will be greatly handicapped in later life, when he should be stepping up to higher executive positions.

The engineering field is broadening and an engineering training is an invaluable asset to any business executive, consequently today, we find many of our principal executives in the larger corporations who are graduate engineers. They may never have followed engineering as a profession, but concede that such a training has been invaluable, giving them a better understanding and a clearer insight into the business which they are directing.

It is said that during the past decade there has been a greater development in the arts and crafts, many more epoch-making inventions and discoveries, covering every possible branch of human endeavor, than has been made in the entire preceding period, dating back to times prehistoric, but my prediction is that during the next fifty years we shall see even more progress

(*Continued on page 314*)

TECHNOLOGY BRANCH
"THE COOP"
Is the Christmas Gift Shop for Technology men

Our jewelry department offers an interesting assortment of gift suggestions

Waldemar Chains	$1.00–$3.50
Brooches and Charms	1.00–15.00
Rings of silver or gold	3.00–17.50
Compacts	1.75–10.00
Bracelets	5.50– 9.50
Bar Pins	3.50–10.75
Chains	1.00– 8.00
Lingerie Clasps	2.50– 8.00
Knives	2.50– 5.00
Cuff Links	3.50– 4.50
Paper Cutters	1.00– 1.50

Room Decorations

Banners, Pennants and Pillow Covers in cardinal red and gray.

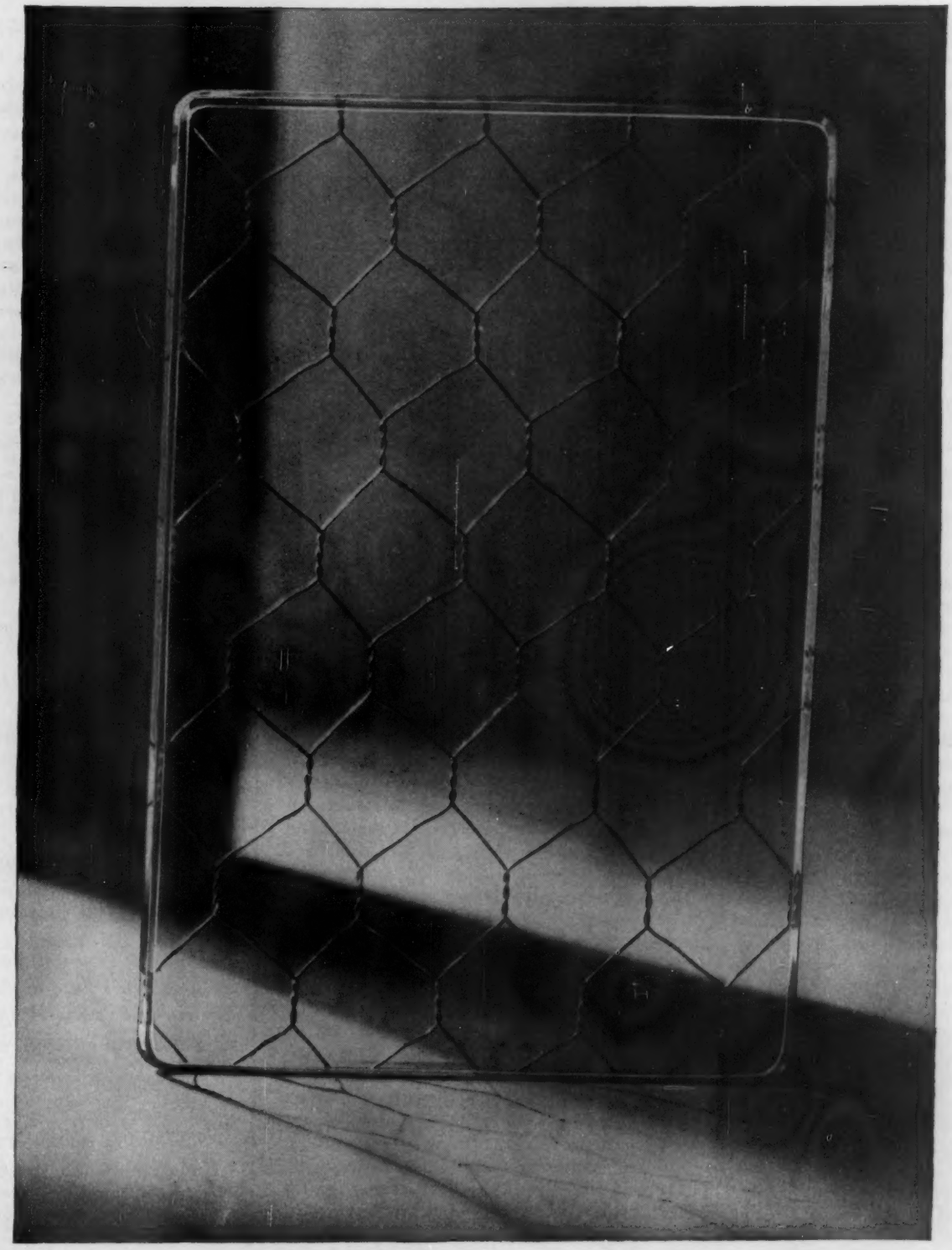
M.I.T. Seal mounted on oak plaque	$3.00–$5.00
Book Ends	2.95– 6.00

Harcourt Equipment for Chemistry

K KNOTT

L. E. KNOTT APPARATUS COMPANY
CAMBRIDGE, MASSACHUSETTS

SINCE 1895



Mississippi Polished Wire Glass

The wire glass with the plate glass finish that protects thousands of fine buildings when the neighbors are on fire. Particular architects specify it because its high quality has won recognition everywhere. If you want safety and security you will also specify "Mississippi"—the standard since the standard was created.

MISSISSIPPI WIRE GLASS COMPANY

CHICAGO · 220 FIFTH AVENUE · NEW YORK · ST. LOUIS

Technical Training—Plus

(*Continued from page 312*)

and greater development in all things.

A great many years ago, about 1850, in a debate over a congressional report, concerning the patent office, the statement was made that probably all the great epoch making inventions had been conceived and all subsequent inventions would be in the form of mere improvements in design. Considering our past performance since that period, how can we possibly sell our country short? I do believe, however, that the trend of inventions will not be quite so radical, due to the corrective and constructive work being done by thousands of engineers working so diligently in our industries.

In closing, I should like to give a little homely advice, which I have gathered by close observation of many leaders in the engineering fraternity and that is, that high scholastic standing is always extremely desirable, but by no means the only requisite.

It is imperative that you develop a broad vision and do a good deal of biographical reading on the side. Never lose an opportunity of obtaining an interview with a great and successful man, not that you will of necessity copy his ideas or methods, but that you will in all probability obtain an invaluable inspiration for your success.

Remember that the professional impression you make upon your prospect, or your superior, is fully as important as your possession of great knowledge. Colleges are beginning to recognize this fact and are literally beginning to turn out professional actors on the great stage of life.

A Squeeze Riveter of novel design has recently been developed. It differs from the usual type in that it has bolted to it a yoke which fits over the pieces to be riveted and holds the rivet in place.

Its outstanding points are light weight, low cost, and the fact that with it one man can do work that with the ordinary riveting gun requires two.

A large number of interchangeable yokes is furnished so that a variety of requirements may be met.

Railroad Course

(*Continued from page 292*)

the same in the other departments. The group which is now with the Mechanical Department of the Railroad will return to the Institute for the second term of the present year. During succeeding work periods this group will get practical experience in other branches of the operating department, typical schedules for which follow:

Maintenance of Way. (*a*) Office of chief engineer, engineer maintenance of way, or division engineer; (*b*) bridge engineer's office (or inspector of construction); (*c*) track work; (*d*) signal department.

Conducting Transportation. (*a*) Station work; (*b*) yard work; (*c*) freight service; (*d*) passenger service; (*e*) freight house operation; (*f*) car service office; (*g*) division superintendent's office.

General. (*a*) Accounting; (*b*) stores (including inspection and testing of materials); (*c*) research and special investigations.

The course in Railroad Operation (I-A) is administered through the Civil Engineering Department, and one of the members of the staff acts as liaison officer between the Institute and the Railroad. It is his duty to keep in touch with the students on coöperative work and with the railroad supervising officers under whom they are working.

Although students receive reasonable compensation while with the Railroad, the purpose of the coöperative work is not primarily to enable students to earn money, but it is to give them an opportunity to get practical railroad experience. It should be borne in mind that the course in Railroad Operation is based on a fundamental engineering background which includes much of the work in the civil, electrical and mechanical engineering departments, together with certain railroad subjects which are planned to tie in the work at the Institute with that at the Railroad. The fifth year at the Institute is devoted to graduate work; during this period the individual student will pursue further particular phases of railroad operation, such as terminal design and operation, locomotive engineering, fuel economy, electrification, and motor transport.

Industrial Museum

(*Continued from page 284*)

to the general visitor will be kept catalogued and made available to those who have reason to make special studies. Altogether, the museum should not only be a valuable aid to the universities and schools generally, but it should stand as an ever ready means of clarification of our abstruse, mechanistic world to those who have long since graduated as well as to those who have taken other routes of education.

The Museums of the Peaceful Arts is being backed by a group of men nationally known for their ability to carry things through.

DE PONTIBUS

A Statically Indeterminate Love Song

(*Reprinted from "The Technograph"*)

I stood on the bridge at midnight,
A simple Pratt-truss span,
And my fingers were held fixed-ended
In the clasp of my love — dear Ann.

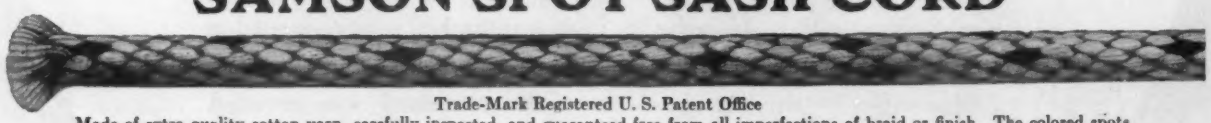
And I sighed as I there surveyed her,
My love so passing fair.
While a sportive wind load sudden
Caused tensile stress in her hair.

"Ann, wilt thou walk beside me
'long Life's hard surfaced road?
On my ribs spiral reinforcement
My heart sets up an impact load."

"Oh, Ann, beam thou upon my life
I pray thee do not dim it."
And my joy, when she softly whispered "Yes"
Exceeded the elastic limit.

— Author in hiding.

SAMSON SPOT SASH CORD

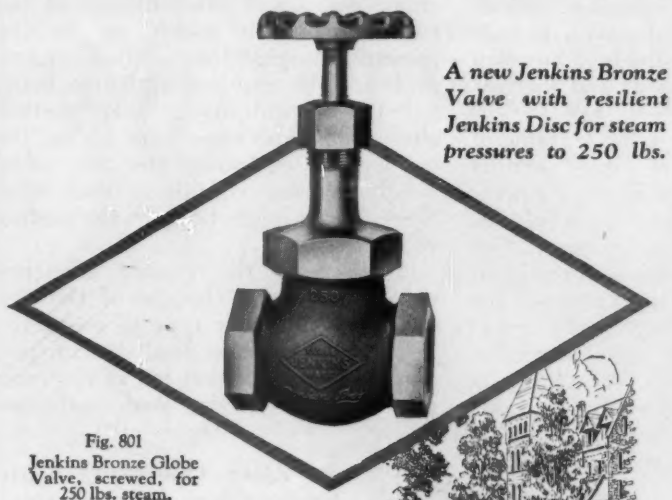


Trade-Mark Registered U. S. Patent Office

Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS : : **88 Broad Street, Boston 9, Mass.**



A new Jenkins Bronze Valve with resilient Jenkins Disc for steam pressures to 250 lbs.

Fig. 801
Jenkins Bronze Globe Valve, screwed, for 250 lbs. steam.

Traditions—
in college and in business

At every college, long-standing traditions are part and parcel of a student's life. Campus customs and campus ceremonies have a profound effect on the characters of students and graduates alike.

The effects of long-standing traditions are noticeable in business organizations, too. The Jenkins tradition, established in 1864, demands that valves be made for the maximum service not merely the average, and that standards of manufacture should be maintained at the highest level.

The effects of this tradition are apparent in the reputation of Jenkins Valves and the favor they find with consulting and operating engineers throughout the country.

Send for a booklet descriptive of Jenkins Valves for any type of building in which you may be interested.

JENKINS BROS.
80 White Street ..... New York, N. Y.
524 Atlantic Avenue ..... Boston, Mass.
133 No. Seventh Street .. Philadelphia, Pa.
646 Washington Boulevard .. Chicago, Ill.
JENKINS BROS., LIMITED
Montreal, Canada London, England

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864

GOOD EQUIPMENT
is the backbone of
MODERN PRODUCTION

GOOD EQUIPMENT is the most economical for the modern manufacturer to buy since its cost is low compared with the investment it affects.

Brown & Sharpe Equipment has been giving thoroughly satisfactory results for nearly a century in shops all over the world. For accurate gauging, measuring and testing it is recognized as world's standard. The traditional accuracy helps decrease spoilage thru errors in measuring and the modern design saves time and money by helping the workman to get better production.

Over 5000 items are listed in the Brown & Sharpe No. 30 Small Tool Catalog,—Tools, Milling Cutters, and a wide variety of miscellaneous Equipment. Students planning to enter the industrial field should have a copy of this catalog. Write today.

BROWN & SHARPE
BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

Book Reviews

(*Continued from page 298*)

era of military use is stressed, and the several ways in which the war stimulated research and pushed the industry ahead by leaps and bounds are noted. The United States, the country which has previously been so backward in this line, came to the fore at this time, and since then has led the world in production and experimentation along these lines.

The last part of the book is concerned with the era of popular use and records in some details the attendant legislations in this country. For the first time we follow the various changes in governmental policy and at last arrive at an understanding of the seeming contradictions in their present law. We repeat, for the man who enjoys a historical biography, we recommend the "Rise of Radio" without reservation. H. A. R.

A New Automatic Loom, called "Cotton King," has recently been developed by a loom manufacturing concern for the requirements of versatile and high speed production. It is capable of great elasticity of operation, for not only will it produce fabrics ranging from the finest voiles, including rayon, to heavy ticking, but will weave them at high speed and without the usual difficulties.

The building of the outside frame of this new loom in three pieces permits easy filling of the magazine and makes it possible to use short and long bobbins in the loom at the same time. The outside pieces are especially finished to prevent chafing or untwisting of the filling yarn, thus eliminating the breakage of the filling at the time of transfer. The special chrome-nickel steel bolts used throughout the machine eliminate the stretch and the consequent loosening of the parts, thus prolonging the life of the machine.

With the new loom, production is more profitable, not only through more yardage of better quality but in the reduction of waste, operation of more looms per weaver, and at the same time lower maintenance costs.

A Cooling System of the vertical trunk brine type, replacing the older forms of refrigerating units employing shell and tube brine coolers, has recently been perfected by a Pennsylvania concern.

This new type of refrigerating machine uses a salt brine instead of the calcium solution which up to the present has most frequently been employed. The required ammonia being fed by an automatic float control, eliminates hand expansion. Also, the evaporator embodies the use of a solidly welded container, such that there are no joints beneath the surface of the brine.

Aside from the greater efficiency obtained, due to the use of the new salt brine and new type of container, the automatic float feed control prevents excessive superheat at the compressor under varying load conditions.

A New Valve Operating Unit, which is motor driven and makes possible automatic operation of all valves up to 6 inches, has been announced. It can be operated automatically either by push buttons or by float switches, temperature controlling devices or by pressure regulators.

Although while it was first designed for service in industries where regulation of pressures and temperatures is a requisite, it is likewise adaptable to many miscellaneous applications, such as operating skylights and radiators.

Steel Sheets

Sheet metal serves increasingly the engineering, railway, industrial, and general construction fields. This Company is the largest and oldest manufacturer of Black and Galvanized Sheets, Special Sheets, Tin and Terne Plates for every known purpose—and with highest quality standards rigidly maintained. Sold by leading metal merchants. Send for booklets.

Black Sheets
Blue Annealed Sheets
Full Finished Sheets
Automobile Sheets
Special Sheets
KEYSTONE
Rust-resisting
Copper Steel Sheets
Galvanized Sheets
Corrugated Sheets
Formed Products
Tin and Terne Plates
Black Plate, Etc.

AMERICAN SHEET STEEL Products

AMERICAN SHEET AND TIN PLATE COMPANY
General Offices: Frick Building, Pittsburgh, Pa.

DISTRICT SALES OFFICES:—CHICAGO, CINCINNATI DENVER, DETROIT, NEW ORLEANS, NEW YORK PHILADELPHIA, PITTSBURGH, ST. LOUIS

Export Representatives—U. S. STEEL PRODUCTS CO., New York City
Pacific Coast Representatives—U. S. STEEL PRODUCTS CO. San Francisco, Los Angeles, Portland, Seattle, Honolulu

CONTRIBUTOR TO SHEET STEEL TRADE EXTENSION COMMITTEE

MATHEWS FIRE HYDRANTS

CAST IRON PIPE

Sand Spun or Sand Cast for Gas and Water

FITTINGS

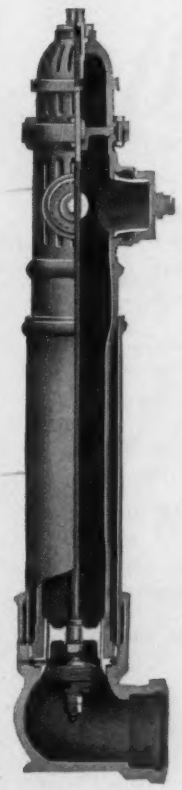
Gate Valves and Boxes

Hydraulic Tools, Valves Fittings

Gas Producers

Gas Machinery

FOUNDRIES AND WORKS, FLORENCE, NEW JERSEY



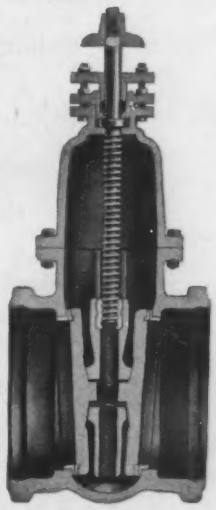
THE "MATHEWS" FIRE HYDRANT dates back to the late sixties, when Hydrants were largely the product of local foundries and the designs many and varied.

"MATHEWS" immediately gained favor and rapidly became the STANDARD for COMPARISON.

Today, with over three hundred thousand in service, it occupies first place, and the long list of users is constantly growing.

Our long experience has brought steady improvement in the details of construction, but because of the fundamentally sound principle there has been no radical change in the essential features of design. Correct design and substantial construction account for the success of the "MATHEWS" Hydrant.

We extend an invitation to all interested students to visit our extensive plant to observe the manufacture of "MATHEWS" Hydrants, and our other products.



CAST CENTRIFUGALLY IN SAND MOLDS

R. D. WOOD & COMPANY

Engineers, Iron Founders, Machinists

PHILADELPHIA, PENNSYLVANIA

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASS.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY offers Courses, each of four years' duration, in Civil, Mechanical, Electrical and Aeronautical Engineering; Naval Architecture and Marine Engineering; Mining Engineering and Metallurgy and Geology; Architecture and Architectural Engineering; Chemistry, Chemical Engineering and Electrochemical Engineering; Biology and Public Health and Sanitary and Municipal Engineering; Mathematics, Physics, General Science and General Engineering; and in Engineering Administration. These Courses lead to the degree of Bachelor of Science.

To be admitted to the first year class applicants must have attained the age of seventeen years, and must satisfactorily fulfill entrance requirements in Algebra, Plane and Solid Geometry, Trigonometry, Physics, Chemistry, English, History and French or German and two units of elective subjects. Examinations are required in all subjects except Chemistry, History and the electives, the requirements for which are fulfilled by the presentation of satisfactory certificates. A division of these entrance subjects between different examination periods is permitted.

Entrance examinations are held at the Institute in September. In June applicants will be examined by the College Entrance Examination Board in Boston, New York, Philadelphia, Chicago and many other cities in America and Europe. A circular stating times and places is issued in advance by the College Board.

Graduates of colleges and scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding to at least one year's work at the Institute, are admitted without examination, to such advanced standing as is warranted by their previous training.

Graduate courses leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy, Doctor of Science and Doctor of Public Health are also offered. Special Research Laboratories of Physical Chemistry, Organic Chemistry, Applied Chemistry and Science have been established.

Correspondence should be addressed to the Institute of Technology.

PUBLICATIONS

Catalogue: Bulletins of General Information, Summer Session, and Graduate Study and Research; and the Report of the President and the Treasurer.

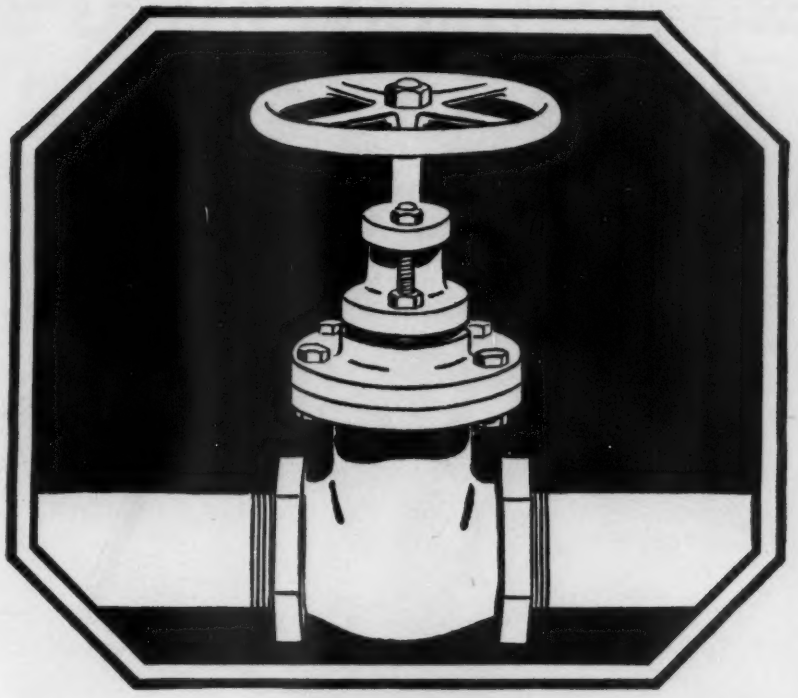
Any of the above named publications will be mailed free on application.

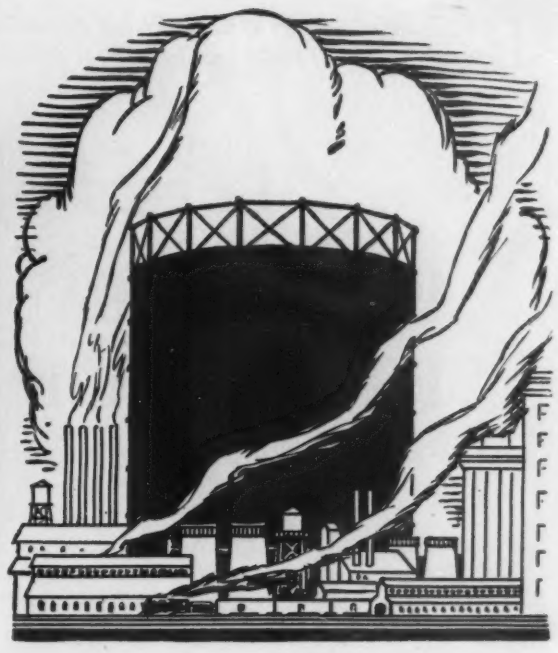
For information address

ADMISSIONS OFFICE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE A, MASS.





HEAT-
the instant you want it!

The moment you are ready for your gas flame, it springs into *full action!*

Likewise, at your will, it is instantly and completely extinguished.

When you use gas, there is no carrying over of fires during periods when heat is not wanted.

Nor is time lost in bringing a fire up to the required temperature.

This feature alone of gas for industrial uses is important. It represents a valuable saving of time; conservation of man-power, and economy of operation.

More than that, the *flexibility* of gas, which makes possible this very feature, insures *perfect temperature control* for every manufacturing process.

Quite naturally, this makes for improved products and fewer rejections.

Considering all the many advantages afforded by gas—of which these are but a few—it is no wonder that industry is today employing gas in 60,000 different ways!

Your local gas company will be glad to tell you how gas can be profitably employed in *your* plant. Telephone or write to them—your inquiry will not obligate you.

For free copy of book, "Industrial Gas Heat", address

American Gas Association
420 Lexington Avenue, New York City

YOU CAN DO IT BETTER WITH GAS

[*This is one of a Series of Eagle-Picher Advertisements appearing in Oil Field and Industrial publications.*]

Let us send you this FREE BOOK

—how three bearing metals meet 95% of all bearing needs

This comprehensive new book describes in detail the development of the three Eagle Bearing Metals which have been scientifically designed to meet 95% of all bearing metal requirements.

The book contains much practical information on the application of bearing metals, and describes the functions of the Eagle Bearing Service.

Send for your free copy today. *The Eagle-Picher Lead Company, Chicago, Joplin, Cincinnati.*

Eagle-Picher Lead Company,
Joplin, Missouri

Please send me, without obligation, your free Eagle Bearing Metal Book.

Name_____

Address_____

EAGLE Bearing Service

1 *Eagle Dreadnaught High-Speed Bearing Metal*—for extreme speed and heavy pressure conditions.

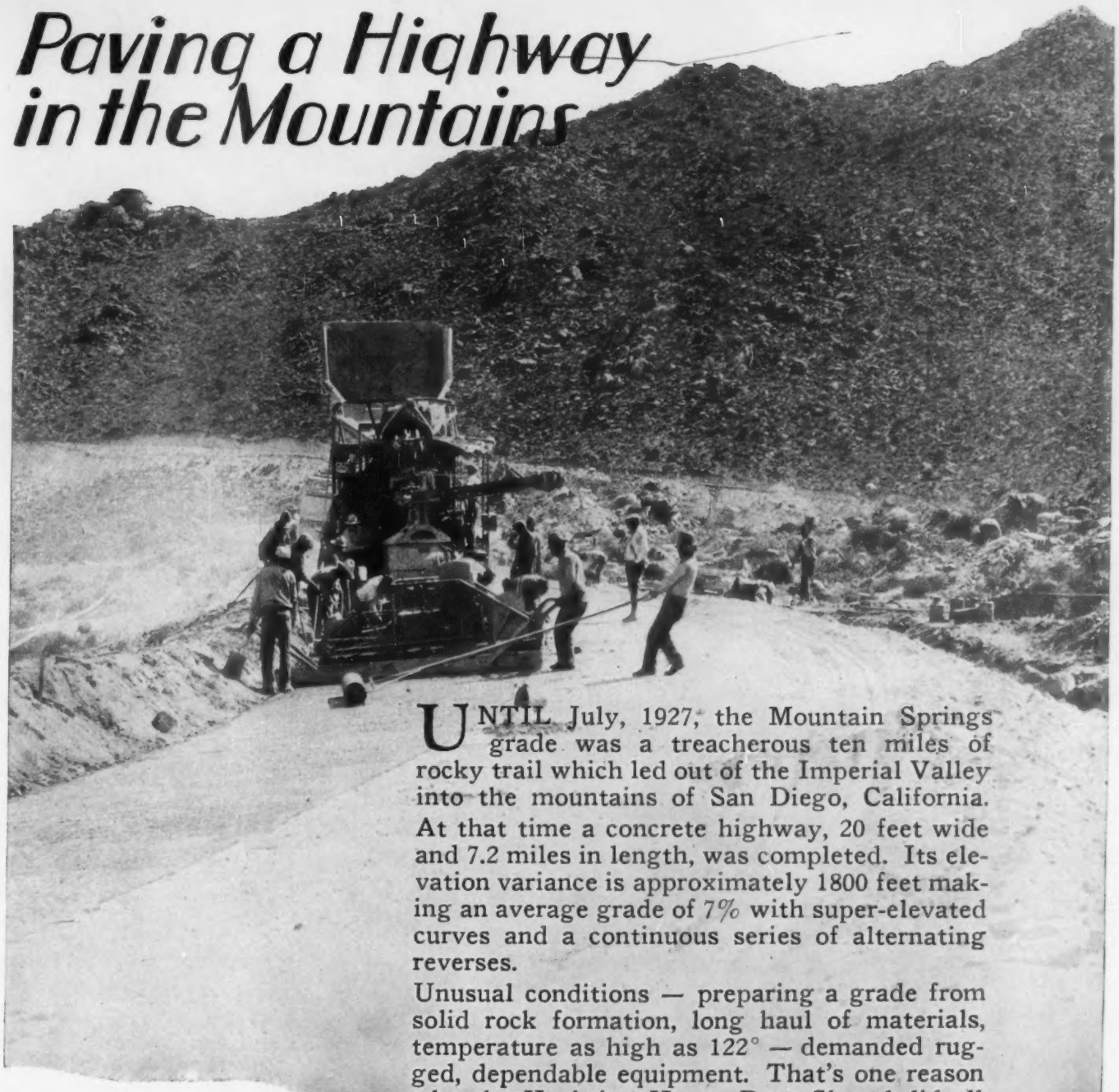
2 *Eagle Outlasta General Service Bearing Metal*—for average speed and pressure conditions.

3 *Eagle Durable Bearing Metal*—for the less severe bearing requirements.

REG. U.S. PAT. OFF.

TECHNOLOGY PRESS, CAMBRIDGE, MASS.

Paving a Highway in the Mountains



UNTIL July, 1927, the Mountain Springs grade was a treacherous ten miles of rocky trail which led out of the Imperial Valley into the mountains of San Diego, California. At that time a concrete highway, 20 feet wide and 7.2 miles in length, was completed. Its elevation variance is approximately 1800 feet making an average grade of 7% with super-elevated curves and a continuous series of alternating reverses.

Unusual conditions — preparing a grade from solid rock formation, long haul of materials, temperature as high as 122° — demanded rugged, dependable equipment. That's one reason why the Koehring Heavy Duty Shovel did all the excavation work — traveling over uneven rock formation.

At the stock pile and batcher bin a Koehring Heavy Duty Crane handled the crushed rock and sand while on the grade a Koehring Heavy Duty Paver mixed the dominant strength concrete, — a complete Koehring-equipped job.

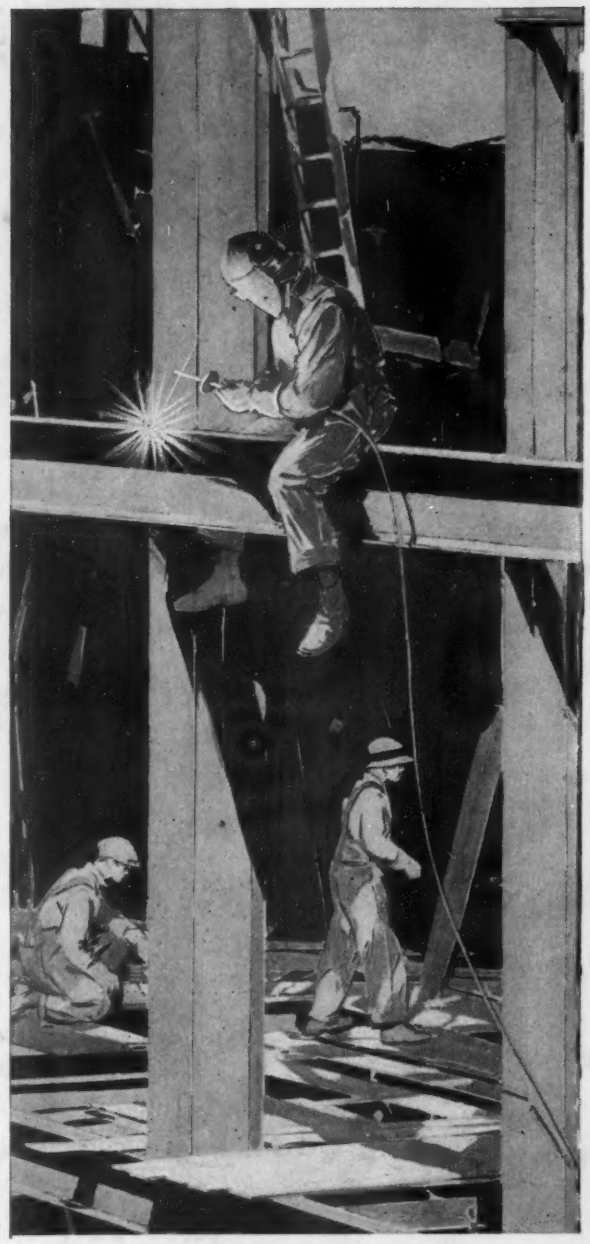
"Concrete — Its Manufacture and Use," a complete treatise and handbook on present methods of preparing and handling portland cement concrete, will be gladly sent on request to engineering students, faculty members and others interested.

KOEHRING COMPANY
MILWAUKEE, WISCONSIN
Manufacturers of
Pavers, Mixers—Gasoline Shovels, Cranes and Draglines

KOEHRING HEAVY DUTY

KOEHRING

Stitching Steel



"IF IT'S better we want it", cries a generation that has witnessed the introduction of radio, television, talking movies, electric ships, and a multitude of other electrical adaptations.

Electric welding, which stitches steel with joints as strong as the metal itself, is now taking an important place in the structural-steel field.

Why?

Because by it building structures are fabricated silently, swiftly, rigidly, and easily, with simplified design, less drafting, and a saving of from 12 to 15 per cent in weight of steel.

To-morrow's engineers are charged with the responsibility of continuing the scientific advance of this electrical age. By utilizing electric power, not only in building construction but in every human activity, they will contribute materially to industrial progress and human welfare.

General Electric manufactures the most complete line of arc-welding equipment. Conforming to the high standards of other General Electric products, such as MAZDA lamps, turbines, and motors, this equipment is identified by the G-E monogram.

95-608DH

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK